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Has any one ever tried to figure out the effect on the business world of a total interruption of all telephone communication?

It would be interesting to know what effect the coal strike and the threatened gas famine have had upon the calcium carbide industry.

The convention at Detroit of the American Street Railway Association last week was in many ways a remarkable one, and it evidenced above all other considerations the remarkable prosperity and the development which are obtaining as the result of the rise of electric transportation facilities. The new president is the executive head of an organization which has had to do with every phase of urban and interurban transportation of both passenger and freight traffic, and the great work which the American Street Railway Association has to this date been responsible for will undoubtedly be furthered and enlarged under his guidance.

ELECTRIC HEATING.

It is probably a fact that few of us realize the extent of the electric heating industry to-day. Do we not look upon this class of apparatus as an expensive toy which can be afforded by the wealthy only—a very pretty contrivance theoretically, but practically of limited use?

The eleventh census, however, shows how erroneous this impression is. Sales of electric heating and cooking apparatus, and of rheostats, amounted in 1900 to over $1,186,000. For 1901 these figures can probably be increased by twenty per cent with a fair approximation of the truth. This is certainly a respectable showing and indicates a well-established industry.

Further, it is stated upon good authority that there are now in use in this country 5,000 chafing-dishes, 50,000 heating irons and 150,000 car heaters. A single hat factory in New Jersey is at present using 250 horse-power for electric heating apparatus alone.

But surprising as these figures may be, they are far from what they should be. Electric heating apparatus has so many distinctive advantages and can be used with so much better effect than other methods of heating, that the question may be raised, why has its application not been more general?

Before seeking an answer to this question, it will be well to examine briefly the various methods of heating now in use, and see wherein lie the advantages and disadvantages of each.

For house heating, the most generally adopted system consists in placing a furnace, burning coal, at some point in the building, and distributing the heat by means of hot air, steam or water, conducted in pipes to the rooms to be heated. This system is probably the least expensive of any to operate, but necessitates a considerable expense in the construction of the house, involving a somewhat costly chimney and a furnace and necessary piping.

Furnaces require a good deal of attention, and bring into the city and house a great deal of dirt in the shape of dust, ashes and smoke. The efficiency of the system is small. There should, however, be no vitiation of the air, and excellent ventilation can be secured. When used for cooking and intermittent heating, however, the economy of coal may be questioned, because it is necessary to keep the fire going continuously in order that it may be in good condition when it is needed.

The use of gas avoids some of the disadvantages of coal, doing away with the dirt nuisance; and it also has a decided advantage for intermittent heating, in avoiding waste of fuel when heat is not required. This probably brings the cost of gas for cooking nearly, if not quite, down to that of coal when used for the same purpose. At current rates for gas and coal, gas for continuous heating is far more expensive, though it can probably be used more effectively. If, however, the gas heater be placed in the living rooms, the air is contaminated by the products of combustion and good ventilation becomes difficult.

The use of oil for heating is practically the same as gas, although this fuel is somewhat more troublesome. On the other hand, it is cheaper. Steam heating, using steam supplied from large stations, is one of the best and cheapest means of warming the house. The installation of steam apparatus is, however, expensive, and there is some liability to leakage. For cooking, however, some other method must be used, as a temperature but little over two hundred and twelve Fahrenheit can be secured by the use of steam.

Turning now to electric heating, we find many decided advantages. There is no smoke, no dirt and no contamination of the air. Consider first its use for

intermittent work. Heat can be instantly developed at the exact place where it is needed—not below the cooking utensil, but within this itself. In this respect, electric heating apparatus is in advance of all others. The efficiency is not only greater, but cooking can be done more quickly and uniformly. The system is under perfect control, and is quite efficient at all rates of heating. With proper attention to insulation, to prevent losses from radiation, the efficiency of this apparatus should be as high as seventy-five to eighty per cent, or even higher. The safety of this system is also good; there is no flame and no danger from fire or explosion.

The apparatus is simple, being nothing more than a suitable form of resistance, and its cost should not be excessive. For continuous heating, the advantage—the question of cost not being considered—still lies with the electric system.

Considering the final test of the applicability of any system—the cost of operation—we find the reason for the poor showing, comparatively, of the electric heating system. When the question of cost is the deciding one, electric heating can not compete with any of the other systems, with the price for electrical energy at its present figure. Heat is heat, no matter how produced, and the advocates of the electric system can not claim, as did the lighting companies in introducing the incandescent lamp, that the product of the electric heater is any better than that of steam or a hot-air furnace. The real advantages of the electric system—and they are not small—are not sufficient at this time to compensate for the greater cost.

When the cost is a minor consideration, we find an increasing use of electric heating. For heating street cars it is practically the only system now in use, as in this particular instance the convenience of having the supply already at hand, as well as the considerations mentioned above, were deciding factors.

It seems evident that the electric power companies are not trying to build up this branch of their business. Electric heaters may be operated from a power circuit, and thus secure better rates than if attached to a lighting circuit. But even this still leaves a prohibitive cost for general use. Some concessions by the central stations are necessary if this industry is to flourish. There is, however, some doubt as to the effect of this load upon the generating station. Electric heating of buildings can hardly be considered at this time, except in very special cases; such, for instance, as in a hospital, where the cost is a small matter compared with the convenience.

For cooking, however, and intermittent work, a slight concession from the central stations would result in a greatly increased use of electric heaters. Except for the cost of operating, electric heating is far better than any other system.

ALTERNATING-CURRENT MOTORS.

As at this time alternating-current motors are attracting quite a little attention, a brief description of their characteristics will not be inopportune. Alternating-current motors may be classified in three types—synchronous motors, commutating motors and induction motors.

The synchronous motor, being nothing more than an alternating-current generator run as a motor, requires a separate exciter, and must run in step with the generator. It has poor starting qualities, and, indeed, in most cases is provided with a starting motor. It, however, has the property of operating with a wide range of power-factor. The power-factor, be it understood, is the ratio between the true energy input into the motor and the product of the voltage and current at the motor terminals. If the current is not in phase with the terminal voltage, the power input is less than the volt-amperes. By varying the excitation of these motors, the current in the armature can be caused to lag or to lead, or theoretically brought into phase with the terminal voltage. These machines have, then, this sometimes desirable property of shifting the phase of the current in the line, and can in this way be used to effect better regulation at the generating station. Where large powers are required and the motors can be put into the hands of competent men, they are very reliable and efficient machines. For small powers, or in cases where it is necessary to stop and start frequently, they are not used.

The commutating motors may be further subdivided into two classes. Consider first one of these—the so-called laminated field motor. The operation of this machine depends upon the fact that if the current in both the field and armature of the direct-current motor be reversed, the machine still runs in the same direction. Therefore, if an alternating current be sent through a motor of this kind it will run continuously, provided sufficient current can be supplied to both the field and armature to develop the requisite torque.

A shunt winding is not suitable for the fields of these motors, because the large inductance of the field coils allows but a small exciting current to pass through. Series windings, however, offer better conditions. Since the field in a machine of this type is an alternating one, it is necessary to thoroughly laminate the field cores, and thus avoid the heavy and wasteful eddy currents which would otherwise be set up in these large masses of metal.

The characteristics of a motor of this type are similar to those of a series motor. The starting effort is excellent, the speed varies inversely with the load, and the motor automatically adjusts its speed to develop the requisite power.

The action at the commutator, however, is usually unsatisfactory. The conditions which effect sparkless commutation in a direct-current machine are not equally effective here, because each coil as it is short-circuited by the brush acts as the secondary of a transformer in an alternating field. Very heavy currents are thus set up and serious sparking results at the brushes. This defect, it is stated, has been overcome by one of our large manufacturing companies.

The power-factor of these motors varies with the load, and with proper attention to the design can be made satisfactory.

The second class of commutating motors is that known as the Thompson repulsion motor. These motors make use of the turning effort developed by a closed loop when placed in an alternating field with its plane at an angle to the direction of the flux. Under these conditions a strong torque is set up, which tends to set

the loop with its plane parallel to the direction of the flux.

If a small drum-wound armature be placed in an alternating field, and the brushes be short-circuited by a conductor and set at an angle to the direction of the flux, we have a condition precisely similar to that just described. The armature will be subjected to a strong turning effort and will commence to revolve. Since, however, the brushes remain fixed in a position, this unbalanced condition persists. The motor gains speed and behaves in a manner very similar to a direct-current series motor. The speed varies inversely with the load, and the starting effort is good.

The power-factor and the behavior at the commutator are similar to those of the laminated field motor. These two commutating motors are at present attracting a good deal of attention, as they possess some properties which are desirable for railway work.

The other class of motor, the induction motor, is probably the most perfect driving mechanism which has ever been developed. It depends for its operation upon the law of Lenz, so important in physical science, which states that the effect of any action is to set up a reaction which opposes the first action. If we spin near a sheet of metal a magnet, currents will be set up in the metal, and will react in such a way as to oppose the motion of the magnet. If the magnet be forced to turn, and the sheet of metal is free to follow, it will follow the magnet.

In an induction motor we have, by virtue of the polyphase currents supplied to the primary, a magnetic field which revolves in the iron of the motor. If this revolving field be caused to act upon a suitable moving part of the motor, this moving part (the rotor, we call it) will follow, so far as it can, the motion of the magnetic field. In these motors there need be no sliding electrical contacts. The moving part need have no electrical connection to outside circuits.

The characteristics of these motors are similar to those of the direct-current shunt motor. The machine is essentially a constant-speed motor. It has poor starting qualities unless provided with certain accessories. For large sizes, a small starting motor is usually provided.

Motors of this type can be operated on single or polyphase circuits. In the first case, however, some auxiliary starting device is necessary, but after the machine is in operation its characteristics are not different from those of a polyphase machine.

ELECTRIC BRAKES.

Electrically equipped cars offer, in addition to their other advantages, several easily applied and effective ways of braking, and one of these should always be provided to prevent accidents in case of the failure of the usual hand-brake.

A simple magnetic brake, excited by currents from the trolley wire, can be attached so as to grip either the wheels or the rail, or a special brake disc. A heavy copper disc, attached to the axle and revolving in a strong magnetic field set up by suitably arranged coils excited by current from the trolley wire, makes a very effective brake. One of these brakes has been used to some extent, both in this country and abroad, and the other has been seriously considered, if not actually tried.

A method which is better than either of the above, as it does not require any additional apparatus except, perhaps, a simple switch, and which does not depend on the trolley, is at present being widely used. This system makes use of the ability of the motors to act as generators, and in this way secures the braking effect.

As is well known, to convert a motor into a generator one of two things is necessary—either the direction of rotation must be changed, or the connection between the armature and field must be reversed. Otherwise the machine will not be self-exciting. Consider a car equipped with two series motors, which is drifting with the controller in the "off" position. Let the two motors be thrown in parallel by a suitable switch. Now, since the relation between the fields and armature causes them to move forward as motors, if they are thrown simply in parallel each machine will tend to demagnetize itself, and the car will drift unretarded. However, if the two motors be thrown in parallel with the fields reversed, each motor, due to its forward motion and the residual magnetism of the fields, begins to act as a generator; and one being always more strongly magnetized than the other will reverse the field of the latter. Both machines then are acting as generators in series on a short-circuit. A heavy current is set up, which very effectively brings the car to a standstill. If the car is on a down grade, it will begin to drift forward again, and the same reactions taking place will again check its forward motion. The greater the speed of the car the greater the effect, and the more quickly is it retarded.

This system is quite widely used as an emergency brake, but it has one defect, which was strongly emphasized in a recent serious accident at Glasgow, Scotland. In ascending a long hill, the hand-brake of a car refused to act when an attempt was made to stop. The car began to drift backward. The motorman threw his emergency brake. This could not be effective under these conditions, as the direction of rotation of the motors had been reversed. The car dashed to the bottom of the hill, collided with another, and several people were killed. Had the motorman reversed his motors when he threw his emergency brake switch, all would have been well. The motorman, however, can not be blamed for this omission. He did not know how the motors behaved, and could hardly be expected to.

Accidents of this kind, of course, could be guarded against by instructing the motorman more thoroughly in the use of the emergency brake; but a system suggested by Mr. G. H. Fawcus, in a recent issue of the London *Electrical Review*, is no more complicated than that in general use, and it is equally effective whether the car be moving forward or backward. To change over to this system, it is only necessary to connect the field of motor No. 1 in series with the armature of motor No. 2, connecting a resistance in parallel, and *vice versa*. If the emergency switch connects the two motors together in this way, the motor having the strongest residual field will begin to build up its own field. This will reverse the field of the first, and the two machines will begin to act as generators on a short-circuit, and the car will be brought to a standstill, no matter what the direction of motion. There should be little difficulty in applying this scheme of wiring to the present emergency brake, and this would prevent a recurrence of such accidents as that at Glasgow.

SOME NOTES ON ALTERNATOR DESIGN.*

BY JOHN DENHAM.

The types of alternators in the market at the present time are so varied in electrical design that it is interesting to analyze their good and bad features. The makers of all of them claim exceptional efficiency, good regulation and perfect parallel working. Probably all modern alternators have good electrical efficiency, but they vary very much as regards output per unit weight at same speed, and also in price. The rated speed of most alternators is considerably higher than one would wish to run them in every-day work; but, no doubt, competition is largely responsible for this state of affairs.

The types I propose to discuss first are: (1) Those in which the magnetic flux through the armature varies in direction; (2) those in which the magnetic flux is constant in direction, but varies in intensity.

Of the first kind there are a great variety, both with disc, drum and ring armatures, some with revolving field and others fixed. Among the latter kind is a well-known disc armature machine and principle in this class of machine being some inductor alternators, the general principle in this class of machine being to have one common exciting coil for all polar projections.

Fig. 1 is a diagram of a six-coil disc armature machine, with six revolving poles alternately north and south. An equal number of poles of opposite sign would, of course, be immediately behind. Fig. 2 shows a disc armature machine with the same number of coils as that in Fig. 1, but with the magnetic flux constant in direction, in which case there must be twice as many coils as polar projections, as the amount generated is due to the difference in the number of lines passing through the coils and not in their direction, therefore three poles only are shown, those of opposite sign being behind. Machines of the disc type, with iron-cored armatures, have been constructed; for instance, about 1882 the late Dr. Hopkinson designed an iron-cored disc armature magneto-alternator, which was made by winding iron ribbon tightly around a suitable ring mounted on a shaft, and milling out radial slots on both sides for the reception of the flat V-shaped coils. The magnet system consisted of some hundreds of steel horseshoe permanent magnets, varying in size with the width of the coils. The output of the machine was very low for its weight, owing to the weak magnetic field, and some difficulty was experienced in keeping the windings in place. Only a few such machines were actually manufactured.

Iron-cored disc machines are now obsolete, though whether they deserve to be —from an electrical point of view—remains to be seen. Of coreless disc dynamos and alternators there were several varieties in the early days, such as the "Arago" disc dynamo with revolving armature and wooden cores, as exhibited at the Crystal Palace in 1882; the Ferranti air core machine, with copper strip wave-wound revolving armature, and the Siemens alternator, with open coils and revolving field. Of later patterns may be cited the "Mordey," with slate or porcelain cores, and the modern Siemens, Ferranti and American Brush machines.

Returning to the figures, assuming in both cases the coils are of the same size and winding, and the poles are equally excited, it is obvious that the coils in Fig. 1 cut twice the number of magnetic lines at the same speed of revolution as do those in Fig. 2. Assuming the magnetic leakage to be the same in both cases, the first machine would give double the output of the second, with the same sized armature and at the same speed, but would need twice the exciting power and be somewhat heavier as regards the field. The leakage between poles on the same crown, and the cross magnetic effect of the stray field would tend to reduce the actual output to some value less than twice that of the second machine. On the other hand, in certain positions the coils in Fig. 2 are not merely not being usefully acted upon, but are in reality so much idle resistance in series with the working coils. Practically only half of the coils are doing actual work in any period of the revolution, and part of the generated pressure is consequently absorbed in the passage of the current through the remaining half of the armature.

Where a single exciting coil is employed the magnetic circuit is usually a long one, especially in machines of large diameter, and there is a large waste field from the shaft itself.

The insertion of an iron core to these machines would, in both cases, reduce the air-gap from, say, one to one-quarter inch, while leaving the actual mechanical clearance the same as before. The iron core would be of considerable benefit to the first machine, as it would reduce the pole-to-pole leakage and the stray field very considerably; whereas in the second machine the iron core would merely have the effect of shortening the air-gap between poles of opposite sign. It might even be deleterious in causing a greater fringe to the magnetic lines, thereby generating opposing electromotive force in adjoining windings. Further, those coils not being usefully acted upon, would be as so many choking coils in the circuit, which would reduce the effective voltage of the machine considerably.

As the mechanical difficulties in the way of building iron-cored disc machines are so great, there must always exist the unusually large air-gap of one inch or more, however small the actual clearance may be. This gap may be even two inches in large machines, where the coil windings are broader to ensure rigidity.

Another disadvantage to the disc machines is that the clamps supporting the coils are subjected to a varying magnetic flux, and although they are usually made of high-resistance metal, the eddy currents must be of considerable magnitude. It is usually assumed that in coreless machines, wound with copper strip on edge, there can be no eddy currents generated, as the laminations are parallel with the lines of force. This, however, is not so. I have experimented with a seventy-five-kilowatt machine, and found that when fully excited, but on open circuit, nine additional horse-power was absorbed over and above that required to run the machine light, and allowing for the power absorbed by the exciter. After running for an hour or two on open circuit, the coils were quite warm, which proved that eddy currents do actually exist. No doubt this is due to the magnetic fringe from the poles striking, to a certain extent, upon the side of the strip and causing eddy currents in its breadth.

Coming now to those machines in which the coils are placed on or in a laminated drum, or are on or in the inner surface of a ring, we have again the choice of alternate poles, as in most alternators, or of a unidirectional flux, as in some inductor machines. The relative gain in using alternate poles, as in Fig. 1, is about the same as between the two types of disc armature machines, but in the drum or ring pattern the actual clearance and the air-gap are synonymous, and may be reduced to one-eighth inch with safety, and a consequent saving of magnetizing power results. A single disadvantage, however, exists in that both the armature ring and the field magnet pole should be laminated.

So far the advantage of output lies distinctly with machines that have alternate poles and drum or ring iron-cored arma-

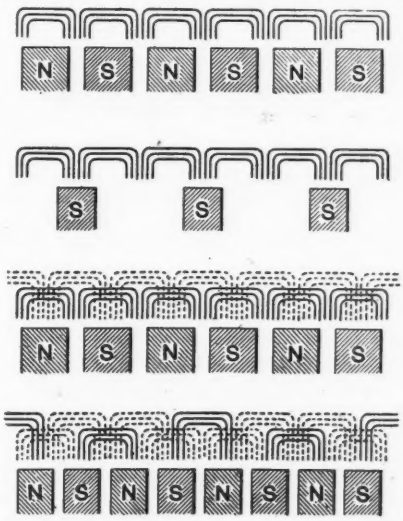
* Paper read before the Cape Town local section of the Institution of Electrical Engineers, April 28.

ture. About twelve years ago there was a great controversy respecting the relative merits of different patterns of alternators for running in parallel. The historic paper by Mr. Mordey, detailing certain experiments made with coreless disc armature machines (which I had the privilege of witnessing) startled the scientific world. Mr. Mordey maintained that the less self-induction, and the less the resistance in or between the two machines the better they would be for parallel working, because anything that tended to retard the instantaneous interchange of current between the two (as one or the other tended to lead or lag) would reduce the force of maintaining them in synchronism. Mr. Mordey, therefore, claimed that the machines of his invention, being without iron in the armature and having a minimum resistance, possess all the necessary attributes, and should—and actually did—work perfectly in parallel. Other eminent electrical engineers maintained that a certain amount of self-induction was necessary for parallel running, and pointed to machines with iron-cored armatures which ran well together. Then the engines driving the alternators were criticised and blamed if paralleling was unsuccessful, and no doubt there was good reason for this in many cases.

High-speed engines receiving a large number of impulses per unit of time naturally give a more uniform torque than slow-speed ones; also, some engines when running light (as when driving an excited but unloaded alternator) take a large gulp of steam one stroke, and none at all for perhaps two or three revolutions, then another gulp, and so on; and in such cases synchronizing is very difficult, but can be rendered easier by applying an artificial load to engine or alternator until the governor allows a certain quantity of steam to be admitted every stroke, when the torque becomes fairly uniform. Probably all modern alternators, whether iron cored or not, will run in parallel when driven uniformly; but if not some will run better than others.

Coreless machines having but small self-induction in the armature, permit the passage of a large current even with but a slight difference in phase, and this large current is needed to keep the machines in step, because it has such a relatively small magnetic effect; whereas a much smaller current passing between iron-cored machines has the same steadying effect, for it must be remembered that it is the magnetic effect produced that pulls and holds the machines into step, and not merely the number of amperes passing. Those who have had to run coreless machines in parallel when driven by slow-speed engines are aware that heavy surgings of current pass between the machines, tending to blow the fuses, and rendering the dynamo ammeters unreadable. This is much less marked with the other type of machine, where the self-induction prevents such sudden rushes, but permits sufficient current to pass to achieve the desired result.

Given uniform angular velocity, there is probably little to choose between the two types as concerns parallel running; but as some of us still prefer slow-speed engines, it would appear to be better to employ alternators that will work in parallel, whether driven by slow or high-speed engines—*viz.*, those with iron-cored armatures. In Figs. 1 and 2 it will be



FIGS. 1 TO 4, RESPECTIVELY, REPRESENTING DIFFERENT TYPES OF ALTERNATING-CURRENT GENERATORS.

noticed that there exists a considerable empty space as core to each coil; such space is frequently two or three times the width of the windings of one side of the coil, sometimes more. If this space is filled in by overlapping coils, as shown in Fig. 3, it is important to notice that without alteration the output of the machine is immediately doubled, at the same speed and with the same excitation, and a two-phase current produced, or two separate single-phases. With disc armatures such additional coils can not be added without doubling the air-gap; increasing the magnetic leakage, etc., it would be actually impracticable. Whether one desires a two-phase current or not, it certainly appears advisable to fully utilize the available armature space, seeing that the dimensions of the machine are not thereby increased. If a three-phase current is preferred, the same armature and number of coils hold good, but the field magnetic poles have to be increased in number (see Fig. 4), involving an increase of some thirty per cent in exciting power beyond that required for two-phase, and greater tendency to leakage between adjacent poles as the pitch is reduced. The output of the machine for the three-phase is the same as for the two-phase. If the load of the station consists principally or entirely of lamps, the substitution of two-phase machinery for single-phase might still be advantageous, as the two-phase could be used entirely separate if desired, and existing mains (even with the outer earthed), transformers, etc., utilized, provided the periodicity was kept about the same. A disadvantage of the bi-phase type is that if the loads on, and the capacity of, the two legs are not approximately equal, some method of adjusting the voltages must be provided. The insertion into the mains of a variable choking coil on the lighter loaded size would answer the purpose, but would have to be of large size to have any effect with small currents, and would cause a lag in the current and a slight reduction in the power-factor.

A better method, and one which is frequently adopted, and, I believe, with perfect success, is to employ a small boosting transformer, one coil being connected across the mains and the other in series with one leg. The series winding has tappings at intervals for connection to a multiple switch, by which the pressure can be boosted up as much as desired. By the use of a reversing switch an opposing voltage can be inserted if the leg in which the booster is placed happens to be the more lightly loaded. Such boosters are very valuable adjuncts, as they can be placed anywhere along the line, giving assisting or retarding volts at the expense of a few amperes.

Existing stations, possessing single-phase alternators, might possibly utilize some of the existing machinery by paralleling one or more single-phase machines, provided, of course, that the periodicity coincided, and that the wave-forms of current were about the same. If, at a future time, a demand for motors arose, the two single phases could be easily combined, and either used as two-phase or converted into three by Scott's method of coupling transformers. As a rule, however, the periodicity of single-phase machines is in the neighborhood of 100, which is too high for motors giving very high speed. This point will be referred to again later on.

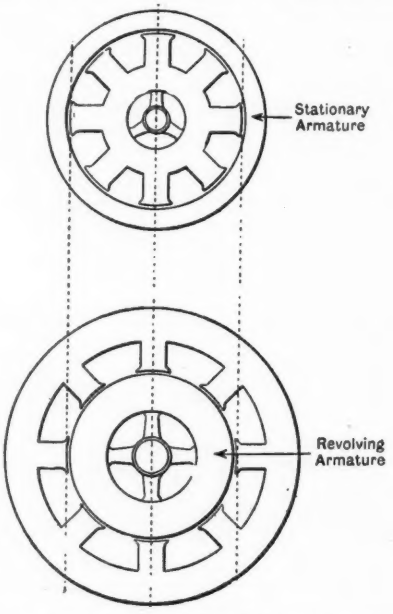
A two-phase machine on this principle will cost more than a single-phase ma-

chine, owing to having twice the number of armature coils, but the cost will not be anything like double, as the full magnetic system remains the same, and the armature reactions are not altered. With disc armature machines, it has been proposed that two or three-phase currents can be produced by removing two or more coils to make room for the angular displacement of those remaining. This, of course, can be done, but it still further wastes valuable armature space, and reduces still more the output per unit of weight of this class of generator, which is very low already compared with the other types. Inductor alternators, whether single or polyphase, can never reach the output attainable from these with alternate poles, as one-half the coils must always be either inactive, or, worse still, generating some opposing voltage. The slight advantage of having all windings stationary, both field and armature, would thus appear to be completely outweighed. Many experiments have been tried, and it appears that the best results are attained with hole or slot-wound armatures, either revolving or stationary, and with two or three-phase connections. The advantages of hole-wound armatures are numerous; they admit of very small clearance, prevent any mechanical stress on the windings, and the conductors need not be laminated, as no eddy currents are generated in them. They are, however, more difficult to wind or repair than those in which the coils are simply wound to form and dropped into slots. In certain cases (instead of windings) single bars slid through an insulating tube and connected by bent strips are used. In large machines of 3,000-kilowatt or 4,000-kilowatt capacity, as high an electromotive force as 6,000 volts can be generated with single bars, and in the case of 8,000 kilowatts 11,000 volts.

This would appear to be an ideal form of construction, as no internal short-circuiting of coils would be possible, and the chance of a contact to frame is minimized by the conductor being actually surrounded by a highly insulating tube. Even if it became necessary to withdraw a bar owing to, say, the insulation being pierced, this is a very simple process, and only calls for the unsoldering of the end connections. This plan, however, takes longer than the replacement of a coil in a disc armature machine.

The next point worthy of consideration is whether the armature or field magnets should revolve. In the first place, it is easier to insulate a fixed than a moving armature, and collecting rings carrying high pressures are objectionable. Secondly, the air churning due to the pole-pieces, while absorbing some power, has the good result of assisting the cooling of the armature.

If the field-magnet system is to revolve, one would probably decide to have an external armature in the form of an outer stationary ring, and from Fig. 5 it will be seen that with a certain number, size and pitch of the poles, the armature has somewhat greater available area for the coils, more cooling surface and shorter magnetic circuit than if the same size, number and pitch of poles were used with an inwardly projecting magnet system and a drum armature as shown in Fig. 6. It will be noticed that in both figures the pitch and number of poles are the same, but the size of the latter machine is very much greater for a slightly less output. It is interesting to observe that the arrangement of armature and field magnets shown in Fig. 6, which would appear to be far less advantageous than that shown in Fig. 5, is, nevertheless, universally adopted as standard for direct-current machines (except in very small sizes). No doubt the reason for this is that were an external stationary armature adopted for direct-current productions it would be necessary to have the complicated brush system fixed to the field magnets, and revolve with them. This would, of course, render any adjustment of brushes impossible while the machine was running, and no doubt this advantage has been the reason for the adoption of the design shown in Fig. 6 in preference. Mechanical difficulties stand in the way of revolving the armature in Fig. 5, but I believe such machines have been constructed by Siemens & Halske. The endeavor to obtain alternate poles with a single exciting coil by interpolating the horns has proved unsuccessful, owing to the great length of the magnetic circuit and the excessive magnetic leakage.



FIGS. 5 AND 6.—FIELD POLES, EQUAL LENGTH, WIDTH AND PITCH.

Most field-magnet systems differ but slightly from the old Lontin type of twenty-five years ago. To economize space and windings it would probably be advantageous, especially where a large number of poles is desired, to have the field coils dropped into slots forming consequent poles and preventing a smooth surface, very much the same as the original Westinghouse alternator armature. There appears to be no reason why the field system should not be of this type, closely resembling the armature by having coils dropped into slots. It is not necessary to have long field magnets, as the air-gap to be bridged is very small. The slots need only be deep enough to permit of sufficient ampere-turns to enable the field to be so stiff as to prevent serious armature reaction. There would, however, be less cooling surface and air churning.

There appears to be no doubt that the greatest output per unit weight can be obtained from a two-phase machine with external fixed ring armature and internal revolving alternate poles (Figs. 3 and 5). If the same machine is intended for three-phase, one-third more poles must be used, which incidentally has the effect of proportionately increasing the periodicity if speed is kept the same, but does not add to total output; in fact, a somewhat greater exciting power must be employed. I recently had the opportunity of experimenting with two three-phase alternators with external fixed armature and internal revolving field, made abroad, and was agreeably surprised with their performance. Facilities for running at full voltage on an adjustable load were lacking, and, therefore, one was unable to obtain sufficient data to plot curves of magnetizing current and output to show regulation. By the courtesy of the manufacturers, however, I have been supplied with a diagram (Fig. 7) showing the inherent regulation and short-circuit curves of their machines. It will be noticed that with constant speed and excitation the voltage fell off seven per cent between no load and full load (inductionless). (A coreless machine curve, see Fig. 8, shows a drop of five per cent.)

The short-circuit current curve in Fig. 7 shows that the full-load current is obtained with 7.5-ampere excitation. If the excitation is arranged for no load and 200 volts, the short-circuit current is three times the normal. If arranged for full load of 500 kilowatts (inductionless), the current is 3.4 times the normal. I have been unable to obtain information as to the short-circuit current with coreless machines, but should consider it would be a much greater proportion than the above. The capability of short-circuiting an alternator, without an enormous current passing, is of but little real importance in practice, as the engine or turbine driving it would in any case slow down, owing to excessive overload. Also, if the exciter happened to be coupled direct to the generator, the field current would die away and prevent the generation of very heavy currents.

The parallel running of these machines coupled to Belliss engines left nothing to be desired; there was hardly a noticeable synchronizing current passing between them, and the load could be easily adjusted to suit their capacities, or could be transferred from one to the other. The following most severe test was applied: One machine was running on a heavy load, and the second machine was run up to synchronism and bus voltage, and was switched in when dead out of phase. The effect was to give a momentary movement to the voltmeter needle, but was too fast to affect the filaments of the lamps, and the incoming machine settled down to work steadily in step with the other. There was no grunting or other noise which is so noticeable a feature in bad phasing of other kinds of machines. When switched in when properly in phase no variation in voltage was, of course, apparent.

Unlike coreless machines, the magnetization of the field does not cause any objectionable hum, with or without load, which noise is so annoying when alternators are running independently and periodically approaching and passing synchronism. After several hours' working at full load, the machine showed no appreciable heating, either of windings or pole-pieces. A good mechanical feature of these particular machines is that the armature frame is made easily adjustable in height to allow for recentering the polar system as the bearings wear.

The armature connections can be coupled in star or mesh as desired. Probably the former is preferable, as it admits of the centre being earthed, thereby reducing the voltage between any line and earth to 0.58 that between wires. Also, each leg of the star can be used as an independent source of alternate current, and the centre being earthed permits the use of ordinary concentric cables, the outer being coupled to the earth centre, and the inner being one of the lines. This, of course, effects no economy in mains, being exactly on a par with a single-phase system, but it might be convenient in utilizing some existing concentric lines. A disadvantage peculiar to armatures connected in mesh is that

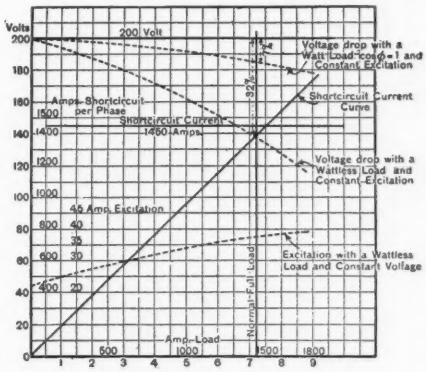

Volts
200 Volt
Voltage drop with a Watt Load-cos Φ=1 and Constant Excitation
Amps. Shortcircuit per Phase
Shortcircuit Current Curve
Shortcircuit Current 1450 Amps.
Voltage drop with a Wattless Load and Constant Excitation
45 Amp. Excitation
Excitation with a Wattless Load and Constant Voltage
Normal Full Load
Amp. Load

FIG. 7.—AMPERE EXCITATION AT SHORT-CIRCUIT.

the three sides may be exposed to varying conditions due to imperfect magnetic or electrical balance, thus producing a current circulating within the closed armature circuit.

An eminent authority on alternating-current machinery recently stated his opinion that the alternate-current motor of the future would be single, not multiphase. Whether this is eventually the case or not, it certainly appears of great importance that the generators should be of two or three-phase, as being adaptable to either or both varieties of motor.

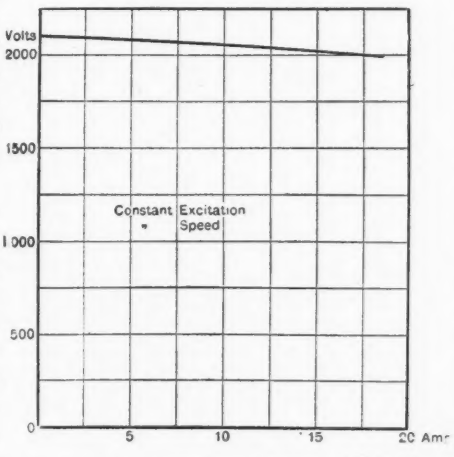


FIG. 8.—CHARACTERISTIC CURVE OF MORDEY ALTERNATOR, 38,000 WATTS.

To those about to lay down a new plant capable of dealing with varied electrical demands, and at all reasonable distances, there can be no doubt of the superiority of the polyphase system of generation. The choice of phase and voltage at generation are quite subordinate details, as the phases can be changed from two or three more phases, and *vice versa*, as may be found desirable, and the voltage ratio transformed up or down as required. Any error in judgment can easily be rectified so far, but in choosing the periodicity one is absolutely committed once for all, and therefore the subject calls for careful deliberation. In the early days, when electric lighting only was called for from alternating-current supply mains, high periodicity, such as the American practice of 133, that of the Brush Company of 100, and of Ferranti of 83, was employed and worked well, as the transformers were of small size. The high periodicity, when used in connection with long underground cables, gave rise to curious effects, which were not easily explicable at the time, and which we are certainly better without.

The present German practice is to use forty to fifty cycles per second, and the American twenty-five only, and this no matter for what purpose or purposes the plant is to be used. Fifty periods appear to be the highest at which one can work rotary converters with any degree of safety and satisfaction, but if one wants certainty of action, no dropping out of step, and perfect parallel running, it is necessary to be much lower than this, say twenty-five. The capability of parallel running of rotaries is determined chiefly by low periodicity; secondly, by even turning moment of prime mover, and thirdly, by design of machine. With twenty-five cycles and steady torque, rotaries work very sweetly and give no trouble.

Rotaries *versus* motor-generators for transforming alternating into direct current is a question that still admits of much argument. Though many devices have been introduced to enable one, where using rotaries, to vary the voltage ratio between the incoming alternating and outgoing direct current, they can not compare with motor-generators, in which the two machines are entirely distinct from an electrical point of view. Further, rotaries call for transformers, as no one wants a constant direct-current pressure of several thousands of volts; whereas the alternate-current motor of a motor-generator set can, whether the motor be of synchronous or induction type, be wound for high pressures, except in the very small size. Still, in designing a plant for universal application, if one can choose a periodicity suitable for rotaries, without detriment to other translating devices, it should certainly be adopted.

High periodicity means high speed of induction and other motors coupled to the circuit, and this is a point which is far more serious in practice than one at first sight imagines. It is all very well to say that a horse-power is the product of speed and torque, and that whether you have a high speed and a small torque or large torque and slow speed is all the same. This only holds good if you want your horse-power at the particular speed at which the motor is prepared to give it to you, but this is very seldom the case, and otherwise there is a considerable loss.

(To be concluded.)

The Electric Nitrification of the Atmosphere.

A Description of the Apparatus and Chemical Reaction under the Electric Arc.

By Wm. Hand Browne, Jr.

NITROGEN, although it is one of the most necessary materials for all animal and vegetable life, and constitutes about four-fifths of the earth's atmosphere, is, under ordinary conditions, one of the most inert elements and can

CHARLES S. BRADLEY, ONE OF THE DESIGNERS OF THE ELECTRIC NITRIFYING APPARATUS.

not in general be used by these living organisms in its free state.

There are, however, certain plants which have associated with them colonies of bacteria endowed with the ability to fix nitrogen—that is, to cause it to combine with other elements such as oxygen and hydrogen, and in this way it becomes available for vegetable food. The main supply of nitrogenous material upon which the plants draw is that formed by the decomposition of all animal and vegetable substances. Here a process similar to fermentation goes on, and the combinations containing nitrogen are converted into other forms, principally ammonia, nitrates and nitrites, and are then suitable for vegetable food.

These processes, however, are exceedingly slow and only sufficient to supply the demands of vegetable life under natural conditions. For this reason all waste animal and vegetable matter should be returned to the land to supply the needs of the living plants.

Under the conditions of our civilization, where population is concentrated in small areas, this is not always done. Most of the refuse of our large cities is destroyed or thrown into the sea. Thus, not only have the fertile lands been exhausted, but the conditions which cause such great loss also call for forced production from the ground and increase the rate of deterioration. In addition to these losses there are 100,000 tons of nitric acid alone used yearly in the arts, and this is all prepared by treating a nitrate with concentrated sulphuric acid, and distilling.

In this necessity for supplying the losses going on so rapidly, the vast deposits of guano, Chile saltpetre and other fertilizers have been of incalculable benefit to the human race. These supplies, however, are not inexhaustible, and we are already beginning to see the end. Sir William Crookes, in his address on the wheat problem before the British Asso-

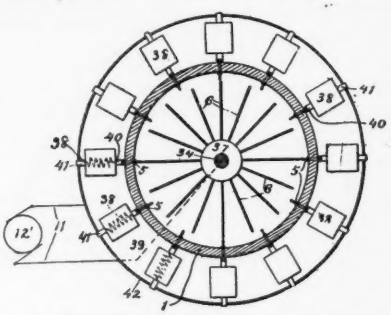


FIG. 1.—SHOWING CONSTRUCTION OF NITRIFYING APPARATUS.

ciation in 1898, stated that unless artificial means for supplying this need were found within thirty years the wheat crop would not be sufficient for the needs of the race and we would be facing starvation.

This startling announcement renewed interest in the problem of utilizing the inexhaustible supply of nitrogen contained in the air. Much work had already been done in attempted solutions, and though combinations could be effected between nitrogen and oxygen, the processes were so inefficient and the output so small that the reaction was only of scientific interest.

The earliest record we have of the fixation of nitrogen is that of Priestley's experiment in 1785 of passing an electric spark through air contained in a tube. He found that a small quantity of the oxygen and nitrogen combined. Cavendish was one of the early investigators, and he, as all other workers on the problem, have made use of the same phenomenon.

The first nitrifying chamber consisted of an inverted V-shaped tube. The upper portion of this contained air, and the legs were partially filled with mercury, upon which rested a layer of a solution of caustic potash. Platinum electrodes were passed up through the legs of the tube until the ends were close together at the top. Upon passing a spark between these, oxides of nitrogen were formed. These reacted with the caustic potash solution, forming nitrates and nitrites.

As a scientific process this method is successful and of value. It was used by Rayleigh in his separation of argon to eliminate the nitrogen from the air. Prac-

D. ROSS LOVEJOY, ASSOCIATED WITH MR. BRADLEY IN DESIGNING THE ELECTRIC NITRIFYING APPARATUS.

tically, however, the process was too slow and inefficient to be used for the manufacture of compounds of nitrogen. Many attempts were made in the last century

to make the process commercial, and various means were employed to cause the spark to pass. Static or influence machines were tried. The combined effect of spark and brush discharge was tested by Prim. Induction coils were employed, and a patent on this application was taken out by Newton as early as 1859. In 1892 Crookes tried high-tension alternating currents. None of these methods, however, promised success.

This was the condition of the problem when Mr. Charles S. Bradley and Mr. D. R. Lovejoy began work in 1899. After long and patient experimentation they have evolved an apparatus which can produce nitric acid on a commercial scale and at a moderate cost.

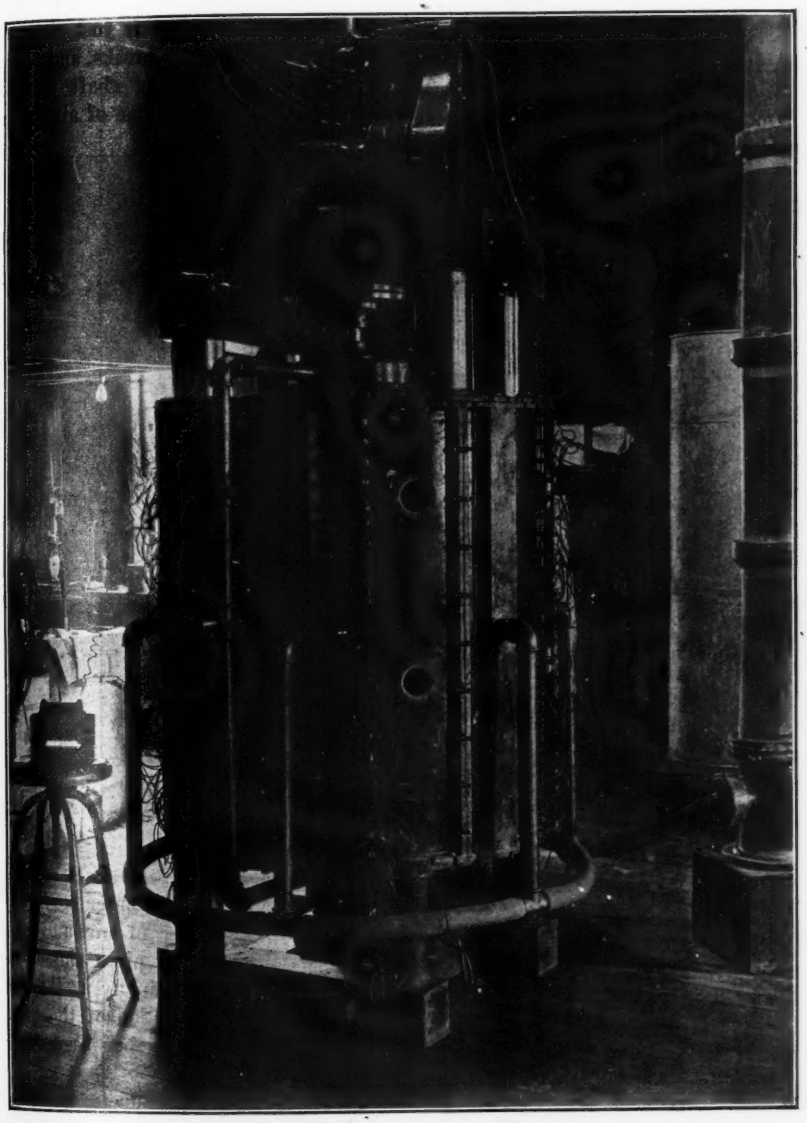


FIG. 2.—THE NITRIFYING CHAMBER, USING DIRECT CURRENT AT 8,000 VOLTS.

In their work it was found that the early apparatus had some serious defects. One of these depended upon the change in the resistance of air when heated. When the potential between two points is increased until a spark passes, the column of air through which this passes is heated and its resistance falls, and a corresponding increase in the current passing between the electrodes will take place. Under these conditions the greater part of the electrical energy is converted into heat, and comparatively little reaction takes place between the nitrogen and the oxygen of the air.

Another defect in the earlier apparatus is due to the dissociation caused by the action of the arc itself upon the oxides of nitrogen as they were formed. To avoid this loss it is necessary that the air which has been exposed to the arc should be removed as quickly as possible.

After studying the effects of different kinds of arcs, both alternating and direct, it was found that a long, thin, direct-current arc was the most efficient. This arc is formed by allowing a spark to pass between two platinum points, and then drawing these apart quickly to prevent an increase in the current, which otherwise would follow the heating of the air. In this way a long, thin arc is formed. The current passing is small, and a larger quantity of air is exposed to the arc. The potential used is about 8,000, causing an arc to jump about three-sixteenths of an inch through the air. In addition to the motion of the electrode, it is found necessary to place in series with the electrodes an inductance coil. This prevents the sudden rush of current which would follow the establishment of the arc, and also maintains the arc for a longer time than would otherwise be the case. The arc does not break until it has reached a length of from six to eight inches.

To prevent the decomposition of the oxides formed by the further action of the arc, the air is kept in motion between the electrodes and is withdrawn from the nitrifying chamber as quickly as possible after it has been subjected to the action of the arc.

The reactions which take place in this process are exceedingly interesting. The air taken into the nitrifying chamber contains oxygen and nitrogen. Under the action of the arc, a small part of these combine to form nitric oxide. This reaction takes place only at a high temperature and is endothermic, that is to say, it is accompanied by an absorption of energy. It has been stated that the reason the reaction is not continuous—that is to say, that it does not go on after being started—is that the temperature caused by the combination of two gases is not equal to that required for the reaction. This, however, is incorrect, because there is an absorption of energy in this reaction, and it therefore has a cooling effect. The energy required is 21,575 calories. Nitric acid is a colorless gas which has the property of taking up oxygen, forming nitrogen trioxide and nitrogen peroxide. Doubtless both of these are formed in most cases, and these reactions are accompanied by a liberation of heat nearly equivalent to that absorbed when the nitric oxide is formed.

These two higher oxides of nitrogen have a red color and a very penetrating odor. They react with water to form nitrous and nitric acids. The following are believed to be the reactions which take place in the process:

(1) $N + O + 21{,}575 \text{ calories} = NO$.

The nitric oxide, NO, may take up additional oxygen, according to either of the following reactions:

(2) $2NO + O = N_2O_3$ (nitrogen trioxide).

(3) $2NO + 2O = 2NO_2$ (nitrogen peroxide).

If the temperature be kept down, these gases react with water in the following way, the result being chiefly nitrous acid:

(4) $N_2O_3 + H_2O = 2HNO_2$.

(5) $2NO_2 + H_2O = HNO_2 + HNO_3$.

At higher temperatures the reactions taking place give nitric acid, as follows:

(6) $N_2O_3 + H_2O = 2HNO_2$.

(7) $3HNO_2 = HNO_3 + 2NO + H_2O$.

The nitric oxide resulting from this reaction then goes through the reaction indicated in equation (3).

In the actual operation it is desirable to prevent the formation of nitric acid in the nitrifying chamber, and for this reason dry air is used. The air is taken in at the centre of the chamber, which consists of a large iron cylinder about four feet in diameter and five feet high. It is taken out in six channels along the side and near the electrodes. There are six vertical rows of electrodes in the present type of apparatus, each row containing twenty-three. These are wires tipped with platinum, having the tip bent upward and passed through porcelain sleeves in the side of the chamber. The wires passing from these electrodes are carried to the inductance coils placed in oil tanks. The other set of electrodes is mounted on a revolving shaft passing vertically through the centre of the chamber and driven by a direct-connected motor placed above. This shaft has six rows of twenty-three arms each, arranged spirally, and all tipped with platinum. Current is carried in by a slip-ring on the shaft, jumps the small space between any two electrodes, and passes out through the coils back to the generator.

The construction of this apparatus is clearly shown in Fig. 1. The cast-iron cylinder is shown in 1, and the vertical shaft carrying the moving electrodes, 6, is shown at 34. The fixed electrodes, 5, are connected in series with the inductance coils, 38, and are connected in parallel by the ring, 42. At 12 is shown the generator connected to this ring and to a slip-ring on the revolving shaft. This figure, however, does not show the vertical air ducts, these being a later improvement.

The object of arranging these electrodes in spiral rows, and not vertical, is simply to distribute the time of striking the arcs and to make the load on the generator uniform. The shaft revolves 500 times a minute, making in this time 414,000 arcs. When the air leaves the nitrifying chamber it passes to a large galvanized iron tank, the object of this being to give sufficient time for the second reaction (that in which the nitric oxide takes up more oxygen) to take place. From here it passes to a vertical tower filled with coke, down which trickles water or any other material. The oxides of nitrogen are absorbed and carried out at the bottom of the tower into a reservoir from which the liquid is drawn, to be pumped again to the top of the tower.

The results of the reactions give a mixture of nitrous and nitric acids, or if the oxides are absorbed by potassium hydrate—as at present is being done—we have nitrates and nitrites. The relative proportions of the two compounds can be varied by varying the temperature. If the chamber is kept cool, more nitrites are formed; if the temperature is raised, we have nitrates predominating. The efficiency of the process is low. Air passes through the chamber at the rate of from three to four cubic feet per minute, and not over three per cent of the nitrogen contained is oxidized. This low efficiency is immaterial so far as the gases are concerned, since the raw material is absolutely free; but it is desirable to secure a greater output from the chamber. This can be done by enriching the air to be treated with oxygen. Work is now being carried on to find the most economical mixture.

At the same time that the enriching oxygen is supplied to the nitrifying chamber, this operation can be used to keep down the temperature of the mixture and thus give complete control of the relative proportions of nitrate and nitrite formed. Fig. 2 shows the nitrifying chamber. The connecting wires for the stationary electrodes will be seen hanging at the side. In front are seen two small windows for watching the behavior of the apparatus while in operation. The air pipes show how the air is led in at the top and bottom of the chamber near the centre. The vertical channels in the side of the chamber are also clearly shown. These channels are covered on the inside with a thin sheet, leaving but a small opening. This opening is just about at the point where the arc breaks, and as the motion of the revolving shaft and its electrodes keeps the volume of air within the cylinder revolving, the effect of these sheets is to shave off the outer surface of the revolving cylinder of air and thus carry out through the pipes shown the oxides of nitrogen as rapidly as they are formed. This modification of the apparatus is quite new, and has been found very efficient.

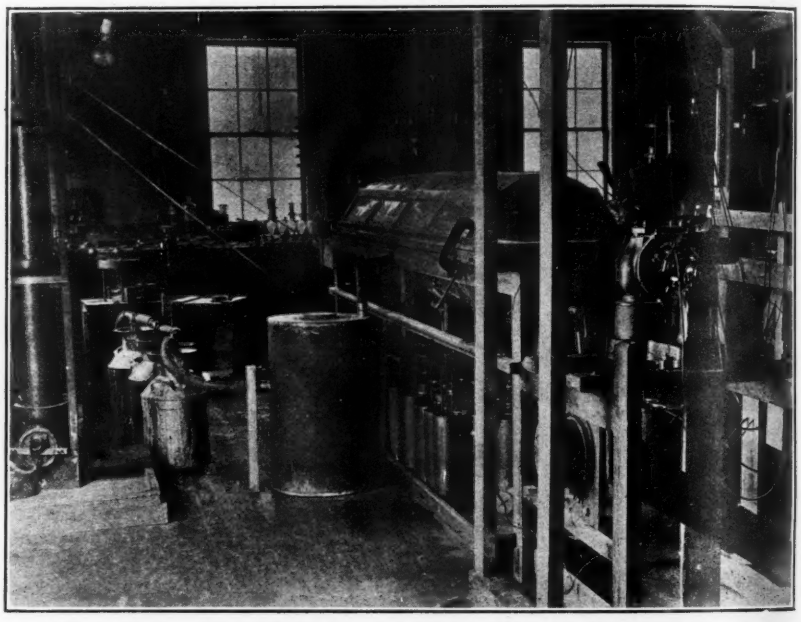


FIG. 3.—EARLY TYPE OF NITRIFYING APPARATUS, USING ALTERNATING-CURRENT ARCS AND A SYNCHRONOUS MOTOR.

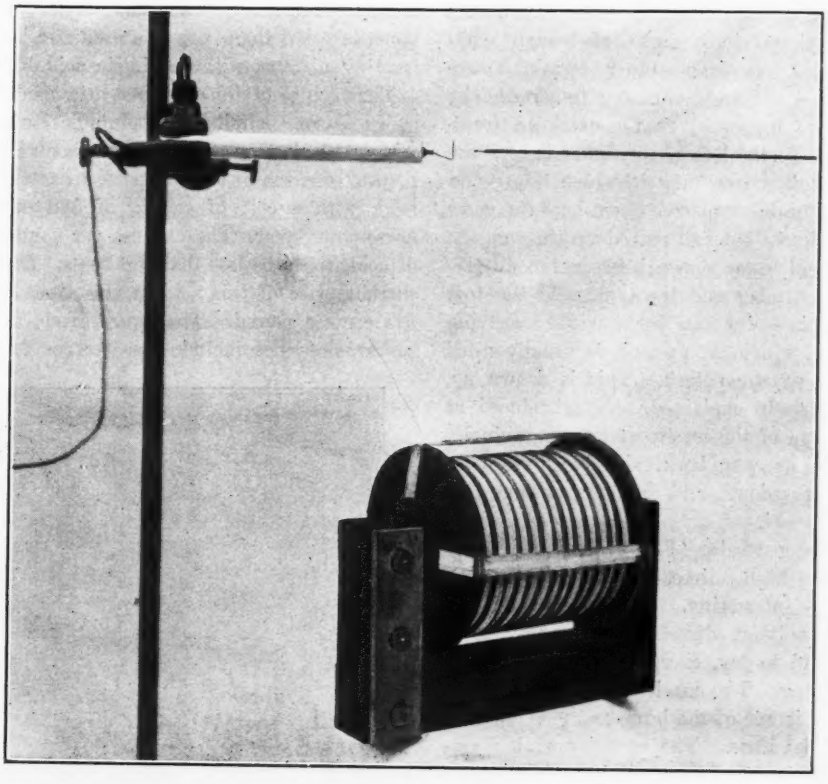
From these vertical ducts the pipes conducting the gases away can be seen. To the left of the nitrifying chamber is one of the inductance coils connected to an electrode. Above the chamber can be seen the driving motor coupled directly to the shaft. This apparatus has been found to be far more efficient than the early types, one of which is shown in Fig. 3. In this machine the nitrifying chamber is horizontal and contains two sets of fixed electrodes and a revolving

shaft having also two sets of electrodes. This shaft was driven by a small synchronous motor, shown to the right, the speed being 1,500 revolutions per minute.

High-tension alternating current was supplied to the electrodes, and as there was but one cycle per revolution it is evident but two sets of electrodes could be used. The alternating current before entering the nitrifying chamber was rectified by a commutator fourteen inches in diameter placed on the shaft. Inductance coils were used to prevent short-circuits at the instant of striking the arc. The output of this machine is comparatively small and not to be compared to that of the apparatus previously described. The machine illustrates, however, the patient work which has been done by the inventors of this process.

Fig. 4 shows a pair of electrodes. The stationary electrode, as previously described, is enclosed in a porcelain sleeve and inserted in the side of the chamber. The wire is tipped with platinum and the end turned upward, this simply to allow for small irregularities in the height of the revolving electrode. The latter is shown on the right, and consists of a steel rod tipped with platinum. As previously described, the arc jumps to the moving electrode when it has approached within about three-sixteenths of an inch, and is then draw out by the electrode moving away from the stationary one. What would be practically a short-circuit is prevented by the inductance coil.

The nature of this arc is very characteristic. It consists of a small violet cylinder surrounded by a reddish flame. The chemical effect of this arc seems to be proportional to the surface exposed, while the energy consumed is proportional to the volume of the arc. This explains the higher efficiency of the small, thin arcs. By using a lower voltage or a higher speed, the arc can be drawn out until it becomes merely a spark. The useful effect of the spark is very small. The chemical reaction seems to produce ozone rather than oxides of nitrogen.



FIGS. 4 AND 5.—SHOWING, RESPECTIVELY, THE ELECTRODES AND THE INDUCTION COIL.

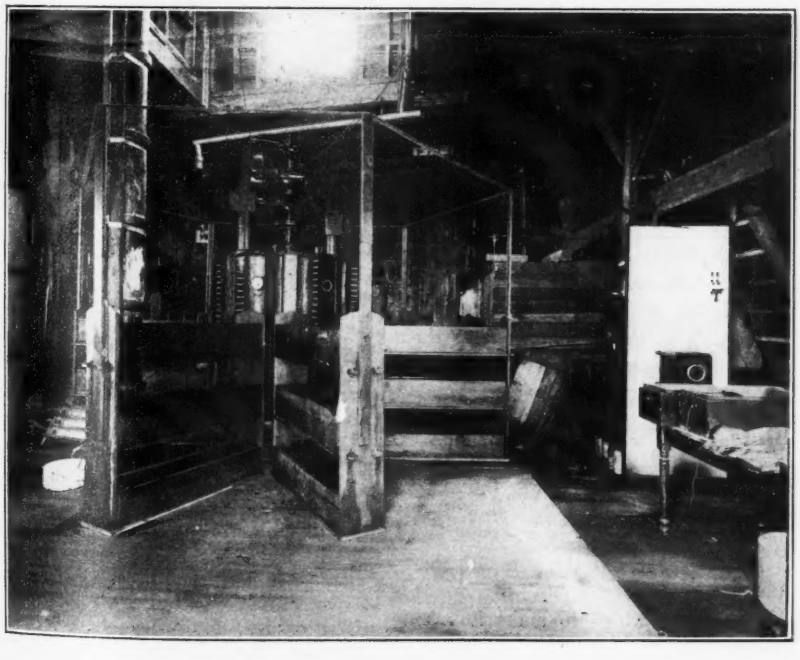


FIG. 6.—THE NITRIFYING APPARATUS.

Fig. 5 shows one of the inductance coils. This coil has been developed after a great deal of study and trouble. In the first coils an open magnetic circuit was used, and the layers of wire were wound horizontally from one end of the bobbin to the other. These coils, although well insulated, were found to be very inefficient. In operation, the wire became quite hot, while the iron itself remained cool. The cause of this, as found by Mr. Lovejoy, was the displaced currents flowing in the coils, and caused by the capacity effect of every pair of layers. To overcome this objection, the coils are now wound in short vertical sections, and as many of these sections mounted side by side as may seem desirable. The magnetic circuit is formed of thin stampings, bolted together, with adjustable air-gaps, which permit adjustment of the time constant of the coil. These coils, when in use, are placed within an oil bath.

The present arrangement of apparatus, which, it must be remembered, is merely experimental, is shown in Fig. 6. The

nitrifying chamber is seen in the centre of the figure, with the driving motor above. The wires attached to the fixed electrodes can be seen passing to one terminal of the inductance coils. These coils are placed in a series of troughs containing oil. The other terminals are carried out and connected in parallel by a wire supported on the overhead framing. To the left of the figure is seen the galvanized iron tank in which the second reaction takes place. From here the gases are drawn out and passed up through the vertical tower shown between the nitrifying chamber and the tank. At the foot of this tower can be seen the receiving vessel which, at present, is usually filled with caustic potash. This is drawn up, as already explained, and introduced at the top of the tower, whence it gradually finds its way back, absorbing gases on the way down, and finally runs back into the vessel.

The generator (Fig. 7) used to produce these high direct-current voltages is quite interesting. There are but few high-voltage, direct-current machines to be had to-day, except those used for arc lighting. The machine selected for this work is one of the large two-pole "Wood" arc dynamos. The capacity at ten amperes is 150 lamps, giving about 7,500 volts. This machine, when used for arc lighting, is furnished with two sets of brushes to ensure sparkless commutation and to permit of regulation. In its present application, the four copper brushes have been removed, and two carbon brushes placed in the holders. An exciter is provided, as shown to the right, giving a very complete control of the voltage of the generator. It was found that this machine, when running unloaded and separately excited, would give 15,000 volts apparently without any distress, and with no tendency to flash around the commutator. When the machine is in operation, the voltage is adjusted by varying the field current, and the brushes are set for minimum sparking. The generator is driven by the 2,000-volt, two-phase induction motor shown on the extreme right.

As already stated, the efficiency, or, rather, the per cent of oxygen in the air which combines with nitrogen, is small, but this feature of the operation is of little importance, except in so far as it limits the output of the chamber. The energy efficiency, however, is also very small, being only about three per cent. This, of course, will affect the cost of the products of operation, and the problem of raising the efficiency is one that is receiving a great deal of study. So far as the commercial application of the process is concerned, however, this point is at present a minor one, since nitric acid can be manufactured in this way at a much less cost than it can be produced by treating nitrates with sulphuric acid.

The results of the tests recently made by Professor Chandler, of Columbia University, show that one kilowatt-year will produce one ton of seventy per cent nitric acid, with a cost of energy of $20 per horse-power-year. The expense per pound of acid would be less than 1.6 cents. The current price of this acid at this time is five cents a pound. The figure given, of course, does not include the charges for interest, depreciation and labor. This last item, however, will be extremely small, since the only apparatus requiring watching will be the generators and the pumps for circulating the absorbing liquid.

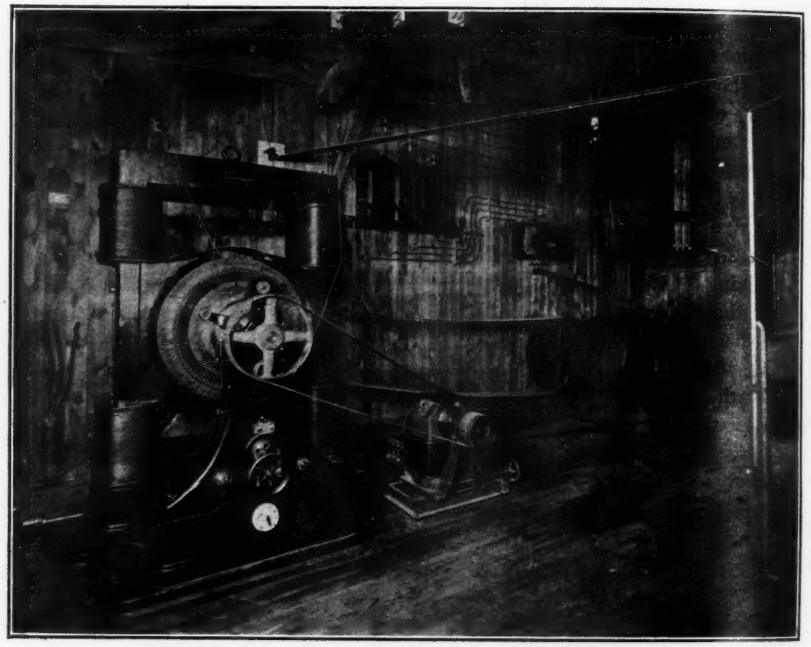


FIG. 7.—THE 10,000-VOLT DIRECT-CURRENT GENERATOR.

It is the intention of the Atmospheric Products Company to erect, as rapidly as possible, a large building, and to furnish this with apparatus which will absorb 100,000 horse-power. This in itself is a great undertaking, and the company has already constructed the building for a machine shop in which to make its own apparatus.

It may be interesting to enquire what effect a plant of this size would have upon our available supply of oxygen. One hundred thousand horse-power applied continuously to cause oxidation of nitrogen might, on first thought, be expected to have an appreciable effect upon the composition of the air. A slight calculation, however, will immediately dispel any fears in this regard. The air consists of about four parts of nitrogen and one of oxygen, so that, making allowance for their weights and assuming that the weight of the gases per square inch of the earth's surface is 14.7 pounds, we have as available oxygen 3.4 pounds per square inch. The earth's atmosphere, therefore, contains approximately 13×10^{15} tons of oxygen. In one year 100,000 kilowatts will produce 100,000 tons of nitric acid, containing 76,000 tons of oxygen, an insignificant quantity compared with the total.

There are many applications in which this process will be valuable, not only in the production of nitric acid and compounds of nitrogen which will be practically pure, but in other operations, such as the manufacture of sulphuric acid, in which oxides of nitrogen are necessary.

The manufacture of fertilizers, as already discussed, will offer a vast field for the system. At the present time, nitrogenous fertilizers usually consist of refuse animal or vegetable matter, or Chile saltpetre. Many soils require lime in addition to this. By exposing limestone to the action of these oxides of nitrogen, calcium nitrate and nitrite can be formed directly without the acids being actually formed, and this form of fertilizer, using as it does a cheap and necessary base, will be very valuable as well as economical.

The oxides of nitrogen can be easily condensed and shipped from point to point, where they may be used to form nitric acid, and in this way effect a considerable saving in freight.

Many other applications of this process could be suggested. At the present time, however, the solution of the fertilizer problem is doubtless the most striking.

THE DESIGNING OF TELEPHONE APPARATUS—V.

W. A. TAYLOR.

In connection with the transmitter and receiver the induction coil plays an important part, especially so in local battery instruments. It would, of course, be possible on short lines to have the transmitter and receiver in series with each other, but on long lines the cutting down of the current would be so great that conversation would be impossible. So, in order to get the full effect of the battery, a local circuit of low resistance is made through to the primary of an induction coil, as is shown in Fig. 8. A represents an induction coil, of which P is the primary and S the secondary windings. LL represents the line wires, C the receiver, D the transmitter and B the battery. Any change in the current flowing from B, due to the variation of the resistance of D, will cause a change of the magnetization of the core of A, due to the action of the current in passing through P. The change of the magnetism of the core will then induce a current into S, which flows out through C, and line LL. The resistance in the primary circuit is very low and consequently any change due to the change of resistance of the transmitter will produce a large change in the flow of the current. Suppose, for example, that the resistance of the primary, P, is one ohm and that of the rest of the circuit one-half ohm, while the normal resistance of the transmitter is ten ohms. A current of three volts pressure will then amount to 0.26 ampere. If the resistance of the transmitter is then increased, due to a sound impulse, to twenty-five ohms, the current would become 0.11 ampere. A difference in flow amounting to 0.15 ampere results. If, now, the transmitter and battery, with the receiver in series, were connected directly in the line without the interposition of an induction coil, and the same change in the resistance of the transmitter were to take place, there would be something like 150 ohms outside the transmitter. Normally, the current flowing would amount to 0.019 ampere. With the increase of the resistance of the transmitter to twenty-five ohms the current would fall to 0.017 ampere, a change of 0.002 ampere, which is very small as compared to the former figures. Another function which the induction coil performs is to increase the voltage of the voice currents, causing them to be carried much farther. This voltage, to a certain extent, is proportional to the turns in the primary and secondary circuits. It is this point which has caused a great deal of discussion among telephone people. Some maintain that a very large ratio between the windings shall be adopted, while others have gone to the other extreme. Of the two sides the latter

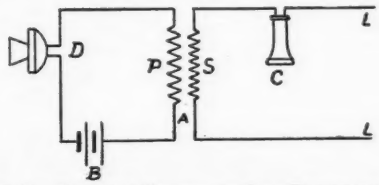


FIG. 8.—SHOWING CIRCUIT OF LOW RESISTANCE.

have the better of the argument as they can show by actual tests that the lower wound secondary gives better results in voice transmission. There are, however, occasions when the higher wound secondary is to be preferred, even if the transmission is to be sacrificed somewhat. Should a high-wound coil, A, be placed at one end of a line, Fig. 9, and a low-wound coil, B, at the other end, the party at the instrument with the low-wound coil would hear better than the party at the other end; that would seem to show that the high-wound induction transmits better than the low-wound coil. This is not a fair test, because the current induced into the low-wound secondary has to meet the high impedance of the secondary of A, while the current induced in A meets a low impedance in B; it is therefore easily seen why there is a difference. It is then best to always test with coils alike on both ends or the results will prove misleading. To get the best results in transmission it is better not to have more than 4,000 turns on the secondary and about seventy-five ohms. The primary winding will depend largely upon the transmitter which is used. If a large current transmitter is used the turns should not be so many, for if there are a great many the core of the coil will be magnetized above the saturation point and consequently a change in the current will produce but little change in the magnetism. The density of magnetism should be at about the steepest part of the magnetic curve so that a change in the ampere-turns will produce the greatest effect upon the core.

FIG. 9.—HAVING A HIGH-WOUND COIL AT ONE END OF LINE AND LOW-WOUND COIL AT OTHER.

Where there are many telephones on a line, as is common on most of the farmers' lines throughout the country, it becomes almost a necessity to have the secondary circuits of a high resistance. These lines frequently have from twenty-five to thirty-five telephones connected and there are always careless persons who will remove a receiver from the hook while another party is trying to signal, or others who will leave the receiver off of the hook. If these secondary circuits were of low resistance it would, under these conditions, be impossible to do any ringing, as the ringing current would find a short-circuit through offending instruments. It was only recently that the writer was asked to furnish generators with telephones so that all the twenty telephones of a line could be rung when half the receivers were removed from the hooks. Such cases as these are met nearly every day by manufacturers who cater to this class of trade and the only solution is to use a 250-ohm or 500-ohm secondary to the induction coil. Some companies have even sent out 1,000-ohm secondaries. Thus is the transmission sacrificed so that a great quantity of instruments may be placed on one line.

The material of the core has a great deal to do with the efficiency of an induction coil. The core, to produce the best results, should be composed of small Norway iron wires, annealed after straightening and cutting. If the core were to be made of solid iron it would act sluggishly, because of the eddy currents that are induced in it. For this reason the core is made up of a bunch of wires. It is better if the wires have a thin coating of iron oxide, as this substance acts as an insulator to the low-voltage eddy currents. The iron should be exceedingly soft, so that the reluctance will be as little as possible. With hard iron it is difficult to change the magnetism and a great deal of the energy of the current is lost. The soft iron produces a very quick acting core. It has been found that the best results are obtained where the spool is about three times the diameter of the winding in length. A long thin coil allows too much magnetism to escape through the turns of the winding, and not around them. The primary should be wound next to the core, with the secondary directly above. The core should be insulated with at least one sixty-fourth inch of paper or fibre and a like thickness should separate the primary from the secondary. All windings should be in uniform layers, as the insulation is less apt to break down under a strain due to lightning or other high-voltage current.

THE CONSTRUCTION OF TELEPHONE EXCHANGES—XLIV.

BY A. E. DOBBS.

If the last few numbers on line testing have seemed a departure from the original purpose of these articles, it is because the writer deemed that sufficient attention had not been paid to that important matter in the past as there should have been, for a telephone man's education can hardly be considered complete till he has learned the proper use of the various test sets, the intelligent application of which is as much a part of telephone construction as a knowledge of poles, wires and switchboard circuits.

It is true that many a construction man, by using standard apparatus and doing as he has seen others do, can lay out and build an exchange by rule of thumb methods with a reasonable certainty of ordinary success, yet practical perfection is only attained in proportion as theoretical perfection is reached and no exchange yet built has attained that desideratum, nor ever will, till a large number of intelligent men working together learn what they want and indicate methods of obtaining it.

A new invention or improvement is offered to the public; it may be a decided improvement over existing apparatus, or it may in spite of its plausible appearance contain weaknesses which the scientific expert would discover and, perhaps, remedy; weaknesses or improvements which would mean success or failure to the investor. It may be that certain insulators give a very fair local service, but fail when applied to long-distance lines, a fault that the well-informed engineer would have discovered before an expensive change became necessary.

Let those who incline to sneer at theorists remember that the possibility of the telephone was first suggested by scientific dreamers and worked out by scientific experts, and has become the efficient instrument it now is by scientific study and experiment in the hands of scientific mechanics.

Instruments have attained a fair degree of perfection, but there is still great room for improvement in construction methods for the engineers of the future to work out, and the surest way to begin such improvements lies in making careful tests and recording their results for future reference. Then will weaknesses be gradually eliminated, improvements suggested and telephony become more fully recognized as engineering science, to which class it properly belongs instead of being merely a trade.

THE OPERATING ROOM.

In the selection of the operating room light and air should always be among the first considerations, for plenty of light not only makes the work much easier for the operators, but expedites the work of answering signals.

Light should be, preferably, admitted from the top so as to strike the face of the board as equally as possible. If this is unattainable, then an effort should be made to have the daylight come from windows in front of the board so that it may strike the face of the board from behind the operator's chair.

For lighting the board in the evenings, or on dark days, the electric light is of course superior to all others, as it gives a stronger light in proportion to its size than any other, is safer, and can easily be concealed from the eyes, by half shades, and made to throw its rays directly on the board and nowhere else, an ideal condition. As to the best method of placing this light practice differs, one method being to place a lamp directly in the centre of each section of the board; but it is the writer's opinion that a much better diffusion is obtained by placing one lamp at each end of a section—one lamp between each operator's position—the lamps being placed horizontally and the light reflected by means of a semi-cylindrical reflector of the Frink pattern running the whole length of the board, the front of the reflector coming low enough down to screen the operator's eyes from the direct rays. In many of the smaller exchanges where the night operator is expected to get as much sleep as he can between calls, there should be a switch within easy reach so that when awakened by the alarm bell he can turn the light on the whole board at once without having to go too far away for that purpose, while by turning it out, as he lies down, he can save meter bills for the company. There are towns, however, where there is no electric light current to be had and gas or oil must be used. In that case, the best place for the lights is above and just behind the operator's chair. Next to the electric light the Welsbach burner is probably the most satisfactory unless acetylene gas can be had, which gives a beautifully soft, clear white light. As to oil, that should never be used at all, if there is anyway of finding a substitute for it, as it is not only a dangerous, but a poor light and a foul smelling nuisance.

By the proper distribution of light an exchange can be made a bright, cheerful place to work in, and it is a mistake to select a dark room unless it can be well lighted.

Ventilation is another matter demanding consideration. Operating at best is rather trying on the nerves and temper, especially to a girl of a restless, lively disposition, and a dull girl has no place in an exchange. The work does not seem difficult, but sitting in the same place for hours at a time, day after day, not knowing just when a call may come in, or having them come in so fast that she has to use considerable ingenuity to keep all the cords she needs, expected to remember all the changes of name and number, continually nagged by irritated subscribers who can not understand why the party they called does not answer and suspected of delaying the call out of personal spite against themselves. All this is very trying, but the best relief for nervousness being plenty of outdoor exercise, it follows that the next best thing is plenty of fresh air in the operating room. It also follows that an operator with a dull, semi-headache feeling about her temples—the direct result of foul air—is not in proper condition to do her best work.

In the laying out of an exchange still further consideration should be shown the operators in regard to retiring and toilet conveniences, lockers, etc., and it is not a bad idea to have a relief girl conveniently by to relieve each girl in turn for twenty minutes or half an hour during the middle of the forenoon and afternoon, thus giving them a chance to walk around a few minutes or even go out on the street. In large exchanges this is a regular practice, and it has been found that the girls return to work refreshed and brighter for their brief respite.

Fig. 190 shows an operator's time sheet taken from an exchange of approximately 500 subscribers, which is not only very busy as an exchange, but does a large amount of toll-line business as well.

Beginning with operator No. 1, who also acts as chief operator, and is given almost absolute authority over the rest in the absence of the manager, which is nine-tenths of the time, we find that together with Nos. 2 and 3 who are the most expert, their work hours are from 7 to 5.30 o'clock or nine and one-half hours. Operator No. 4 takes care of the toll board, except when engaged in clerical work in the forenoon when her place is taken by No. 5. Nos. 6 and 7 are extra operators

who fill in at almost any convenient time in addition to their regular time schedule, or take the place of the regular operator while off duty. No. 8 is a night operator, whose hours are from 6 P. M. to 7 A. M., during which time he gets about six hours' sleep.

The sheet furnishes a very good example of the load curve in a country town of 4,500 population. At 5.30 A. M. two operators are on duty; at six o'clock four operators take their places, and four operators remain on duty till 11.30 when, owing to local time being half an hour faster than standard time, two-thirds of the population are at dinner and three operators can manage the board till 1.30, when four operators are again on duty till eight o'clock, the hours from seven to eight being very busy. After nine o'clock the night operator is in charge of the board, though it is frequently necessary for one of the others to stay longer than schedule time, in which case they, of course, receive extra compensation, as do all the operators who work over the regular time.

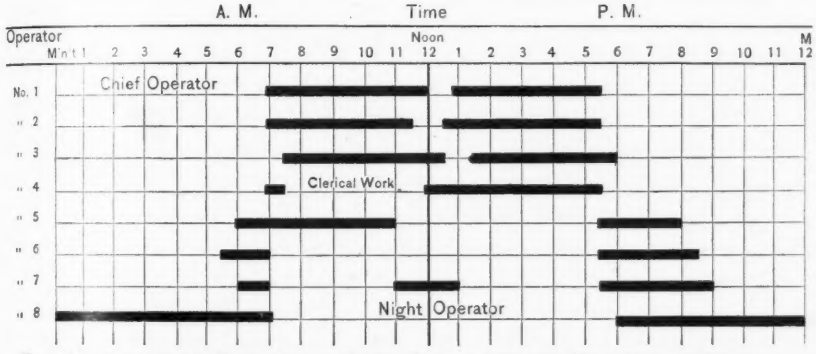


FIG. 190.—OPERATOR'S TIME CHART—LINES ENDING BETWEEN TWO FIGURES INDICATE HALF HOURS.

In large exchanges, management of the operating room is reduced to a system. The need of prompt and efficient service being imperative, and well understood, chief operators and monitors are given almost absolute control of the operators under them and held responsible for results.

In small exchanges, however, the operating department is often left to run itself. The manager, who is perhaps little more than a fairly good lineman, has economy continually dinned into his ears, the owners forgetting, or rather not knowing, that there is such a thing as getting some things too cheap and that certain kinds of economy, in labor and material, is simply money thrown away so far as service or efficiency is concerned.

The worst possible economy lies in purchasing material that will have to be discarded within a year or two, or in making one person, whether operator or lineman, try to do the work of two or three persons, thus creating or permitting a deterioration of service that gives your opponents the advantage of you. An example of this kind of economy is found in the time sheet given in Fig. 190, where, as will be seen, the chief operator is required to take her turn at the board with the rest. An exchange doing as much business as this one should have a better supervision of the operators than is here indicated, especially as the manager is absent from the office fully two-thirds of the time engaged in other duties. A chief operator who did not have to sit at the board, except to relieve the others occasionally, could have her mind free to watch the others, take charge of a great deal of the clerical work between times, answer all complaints and act as assistant manager, thus relieving both the operators and manager of a great deal of unnecessary work that now falls upon them —the operators because they would have only to answer calls, while the manager could give greater attention to other matters. Besides, the chief operator, who takes her turn at the board with the rest and probably with the same rate of pay, does not command the respect of the other girls, and being busily engaged herself she has no time and takes very little interest in what the others are doing, and it would be asking too much of human nature to expect that she would.

Whatever the exchange manager may do, it is a bad idea to imagine that the operators can safely be allowed to run the exchange to suit themselves, though this is the first impression that strikes one in trying to do telephone business in a great many of the smaller exchanges.

The public soon learns to take exchange managers at their true valuation, and the exchange owner who does not take his business seriously enough to give not merely as good, but better service than his rivals will sooner or later find himself falling behind in the race for business.

The manager of a plant of this size is not often to be envied. Receiving the salary only of a first-class lineman, he is expected to act as lineman, inspector, trouble-man—both inside and out—keep the books, look after the collections, frequently act as relief operator and oversee the work of the regular operators. Now it stands to reason that no one man can undertake all this work and do justice to the exchange as a whole. It would be real economy for him to hire a lineman in whom he could place confidence to attend to the construction and inspection work and keep himself close to the office where he could be found when wanted, and at the same time watch the work at the switchboard when there is not a chief operator for that purpose.

There is many a manager who has the ability to do more line work or inspection work than any one or even two men he can ordinarily hire, but for all that he can accomplish more by intelligently directing the work of the others than by trying to do it all himself. The manager who has to do most of the work of the exchange himself will not have time or inclination to attend to complaints, orders for removal, line troubles and many other matters that require a clear head and active brain. The manager who hires others to do the work will have a clear head, can attend to complaints, orders for new instruments, removals, etc. He can also have time to look up new subscribers, make needed tours of inspection, look after the operation of the exchange, see where trouble is likely to occur, look after needed tree trimmings and many other matters of importance to the company as well as the subscribers, and there need be no fear that a conscientious manager will not earn his salary at that.

Returning again to the operating room there are several things that young operators are prone to do that must be thoroughly drilled out of them if quality of service is to be preserved.

First—The habit of listening in on conversations not intended for their ears, and sometimes repeating to outside parties what they hear. In some exchanges this is such an intolerable nuisance that subscribers will not trust a private communication over the telephone at all—although as long as we have cross-talk on telephone circuits a private communication is a risky thing at best—and, in fact, in nearly all small towns mistrust of the operator is almost universal, and not without reason. Telephone communica-

tions are privileged, and it is against the law for operators to repeat them to others.

Second—The habit of gossiping with their acquaintances instead of attending to their work. In some towns this is so bad that subscribers must wait the operator's convenience before obtaining an answer, the writer being acquainted with one instance where a somewhat persistent subscriber stood at the telephone patiently ringing for twenty-two minutes before her ladyship deigned to notice him at all. It might be supposed that this was a case of line or instrument trouble, but it was well known that both line, instrument and drop were in first-class condition, and that the fault lay solely with the operator.

Third—Operators are apt to acquire very strong likes and dislikes for certain subscribers, many of whom they have never even seen, for many very genial and estimable persons have never learned suavity of manner in calling "central," and though their intentions may be of the best, yet something in their manner is rather trying to the operator who answers their calls. Sometimes it seems to be a nervous embarrassment that they never learn to overcome, no matter how often they use the instrument; in others, it is the quality of their voices which, when speaking into the telephone, become harsh and unpleasant; or their articulation jerky and indistinct, although in ordinary conversation such persons may be most agreeable and entertaining. It is to be regretted that operators often make matters worse instead of better in such cases by delaying to answer such calls till they have got every other call out of the way, and in some cases even resort to downright discourtesy in answering. This should not be, and operators should be thoroughly drilled into the idea that all patrons should be treated exactly alike and their calls answered in the order in which they come in. In other words, the operator is little more than an intelligent machine, whose first duty is promptness in answering and connecting calls, and whose second duty is courtesy to all alike, regardless of personal like and dislikes. I am not sure but that I should have placed courtesy first in the above sentence, but both are very necessary. A third quality that is very desirable, and almost as necessary as the other two, is an agreeable and "carrying" voice and clear articulation.

The best operators are generally those who are well educated and who have had good home training, although there are exceptions to this rule.

Such girls as these are usually more courteous and intelligent, and if naturally bright do the best work. There is sometimes, however, one exception to this rule, and that is the girl who is pretty and knows it. Having been used to a certain amount of homage on account of her pretty face and often accustomed to having her own way she is apt to expect favors from the management and sulks if she does not receive them, and often displays considerable impatience with some subscribers and a strong disposition to flirt with certain favored ones. Rather plain girls make the best operators as a rule.

Nothing else will so build up or run down an exchange as the management of the operating room. Of course the construction or instruments may be so bad that the best operators in the world can not give satisfaction, but there is very little excuse for that at the present time when the difference between good and poor instruments does not amount to more than one or two dollars each, with even less proportionate difference in the switchboard.

To the general public the operator represents the exchange and the company. The officials of the company they never meet except, perhaps, in a social or business way not connected with telephone operation. The solicitor they meet once or twice, and, perhaps, never see again after the telephone is in place. The collector they see once monthly, or quarterly, and he is an impersonal being who excites no further interest. But the operator has to be dealt with every time the subscriber takes his telephone from the hook, and the operator is the one who makes friends or enemies for the company. Good operation will do more to build up an exchange than all the rest of the officials put together, and the writer has known operators who were worth half a dozen solicitors.

But they did not receive the pay of half a dozen solicitors.

The Physical Limits of Electric Power Transmission.

In this interesting discussion Mr. Alton D. Adams, in a current number of the *Engineering Magazine,* considers the conditions under which high-tension transmission lines are operating to-day and the possibility of extending these. The given power can be transmitted to any distance with constant efficiency and affixed weight of conductors, provided the voltage is increased directly with the distance. The physical limits of electric power transmission are those fixed by the practical voltage that may be employed. Generators are the points in a transmission system where the limit of practical voltage is first reached. Very few continuous-current dynamos of large capacity have been built, either in this country or abroad, with voltages above 4,000. This is due to the troubles encountered at the commutator. Where transmission at high voltage is to be accomplished with continuous currents, two or more generators are connected in series, and a similar arrangement is adopted for the motors at the receiving station. This system has been used in Europe with a line voltage as high as 22,000. Alternating-current dynamos, delivering current at about 6,000 volts, have been in regular use for several years in large sizes, and at the present time alternating generators have been pushed as high as 13,000 volts. This design, however, gives alternators unusually large dimensions, and the ultimate pressure which can be reached will be 50,000 volts, which is in actual use on present transmission lines. Large transformers are at present being worked regularly at from 40,000 to 60,000 volts. Experimental transformers can now be had, giving voltages from 100,000 to 150,000, and there seems to be no reason, so far as the transformer is concerned, why such voltages should not be used on transmission systems. Considering the line, we have in use to-day systems transmitting power at 60,000 volts. At this point, however, leakage through the air between the conducting wires becomes very appreciable, and increases rapidly with an increase in voltage. This leakage can only be reduced by increasing the distance between the conductors. Results of tests made by Mr. Scott on the Telluride system, Colorado, show that at 40,000 volts the loss between two wires, fifteen inches apart, was about 150 watts per mile. With the wires fifty-two inches apart, the loss was eighty-four watts per mile. At 47,300 volts, the loss between the two wires, fifteen inches apart, was 1,215 watts per mile; while an equal voltage on two wires, fifty-two inches apart, caused a leakage of only 152 watts per mile. Three methods of line construction are suggested to reduce this leakage loss—first, by using heavy poles the lengths of the cross-arms may be increased to twelve or fourteen feet. This would permit the three wires to be placed ten and one-half feet or more apart. The second suggestion is that two light poles be used, with a cross-piece between them. In this way, with a thirty-foot cross-piece, three wires may be kept fourteen feet apart. The third suggestion is that each wire be carried on an independent toll-line. By this means, the distance between the wires may be anything desirable, and the physical limit of electrical transmission will then be dependent upon the highest pressure at which transformers can be operated.

The Toledo Home Telephone Company.

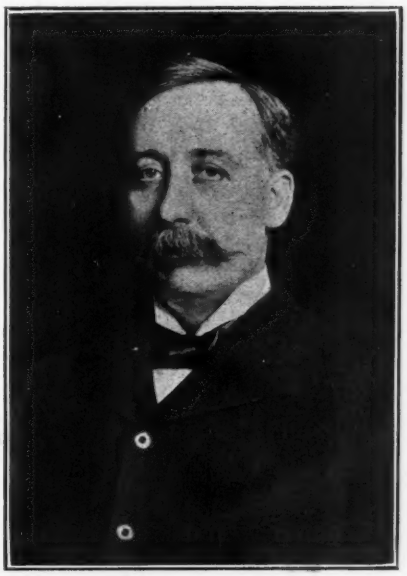
By A. E. Dobbs.

BUFFALO, Cleveland and Toledo, the trio of cities located on Lake Erie, are all ambitious and enterprising towns.

Toledo, with a population of 140,000, is the smallest but not the least ambitious of the three. It possesses more electric lights in proportion to its size than either of the other two, more steam railroad lines than Chicago, in miles of suburban electric railways it is second only to Cleveland—which has more than double the population—and now it bids fair to have more telephones per capita than either of the other two. It was also one of the first cities to encourage independent telephony, and as far back as 1895 gave the Harrison Telephone Company hearty support. With the failure of the parent organization—which, unfortunately, fell into the hands of politicians and "men of influence," whose principal capital consisted of "hot air"—the local company was badly crippled just as it was getting old enough to stand alone, and under the careful nursing of those who had gained control of the stock and whose interests did not lie in the promotion of a competing plant, it soon passed to that Nirvana of peaceful decay, where the "divine unrest" of ambition caused no longing and the struggle for sustenance no further anxiety than a perfunctory presentation of bills.

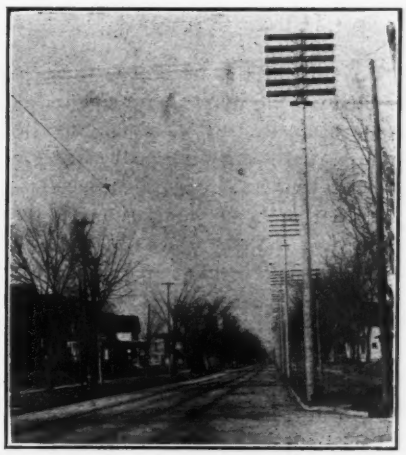
THE BUILDING OF THE HOME TELEPHONE COMPANY, TOLEDO, OHIO.

Under this condition of affairs the people of Toledo were not satisfied with the service given by either company, though satisfied that one company controlled both exchanges.

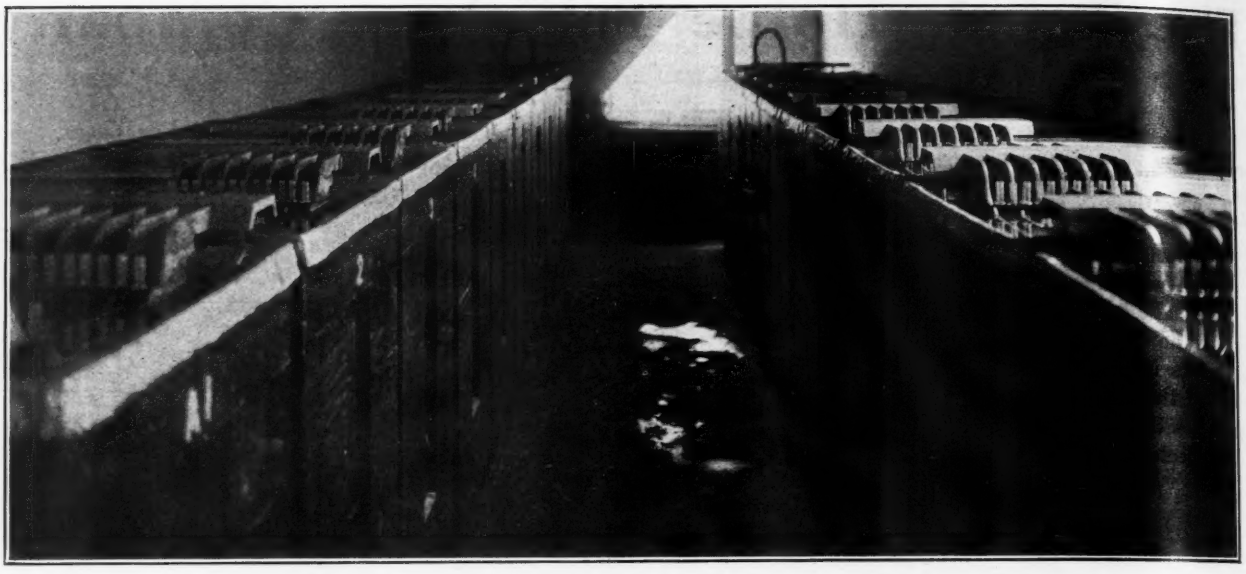


ROBERT E. HAMBLIN, GENERAL MANAGER HOME TELEPHONE COMPANY, TOLEDO, OHIO.

They did not know much about the telephone business, but they did want competing service and firmly believed that local capital could build and operate a telephone exchange and keep their money at home instead of sending it all to the seacoast. They wanted a system whose directors were accessible, who, when things went wrong, could be called up by telephone and called down in all



A POLE LINE IN THE SUBURBS, HOME TELEPHONE COMPANY, TOLEDO, OHIO.



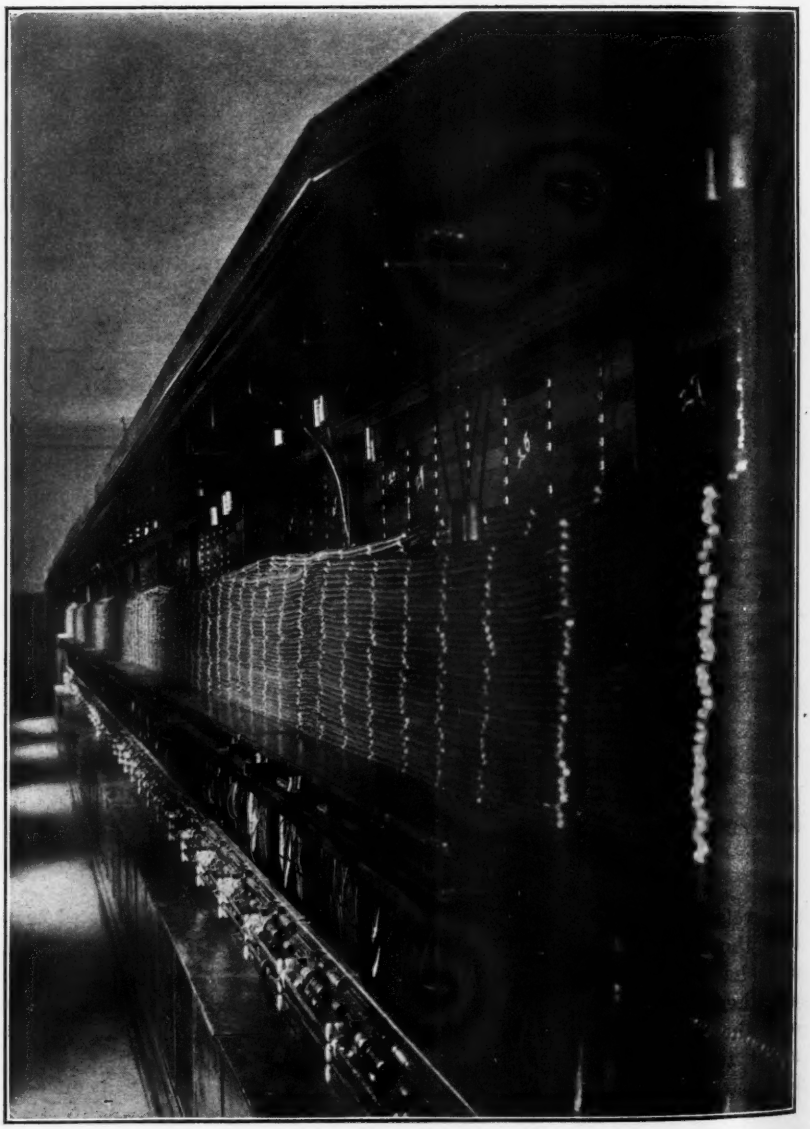
THE BATTERY ROOM, HOME TELEPHONE COMPANY, TOLEDO, OHIO.

languages, but more than all they wanted good service which the various combinations of grounded lines and old-style transmitters never gave them.

Just as when, at the close of the Civil War, it was inevitable that the freed slaves should leave their former masters, however kind, and enjoy a sense of freedom—for a while, at least—by working for whom they pleased or whoever would hire them, so was it to be expected that with the expiration of basic patents, local capital should desire to control the telephone situation, and the almost universal popularity of independent exchanges proved that local management, when applied in a business way, could be made to equal foreign management in the results attained.

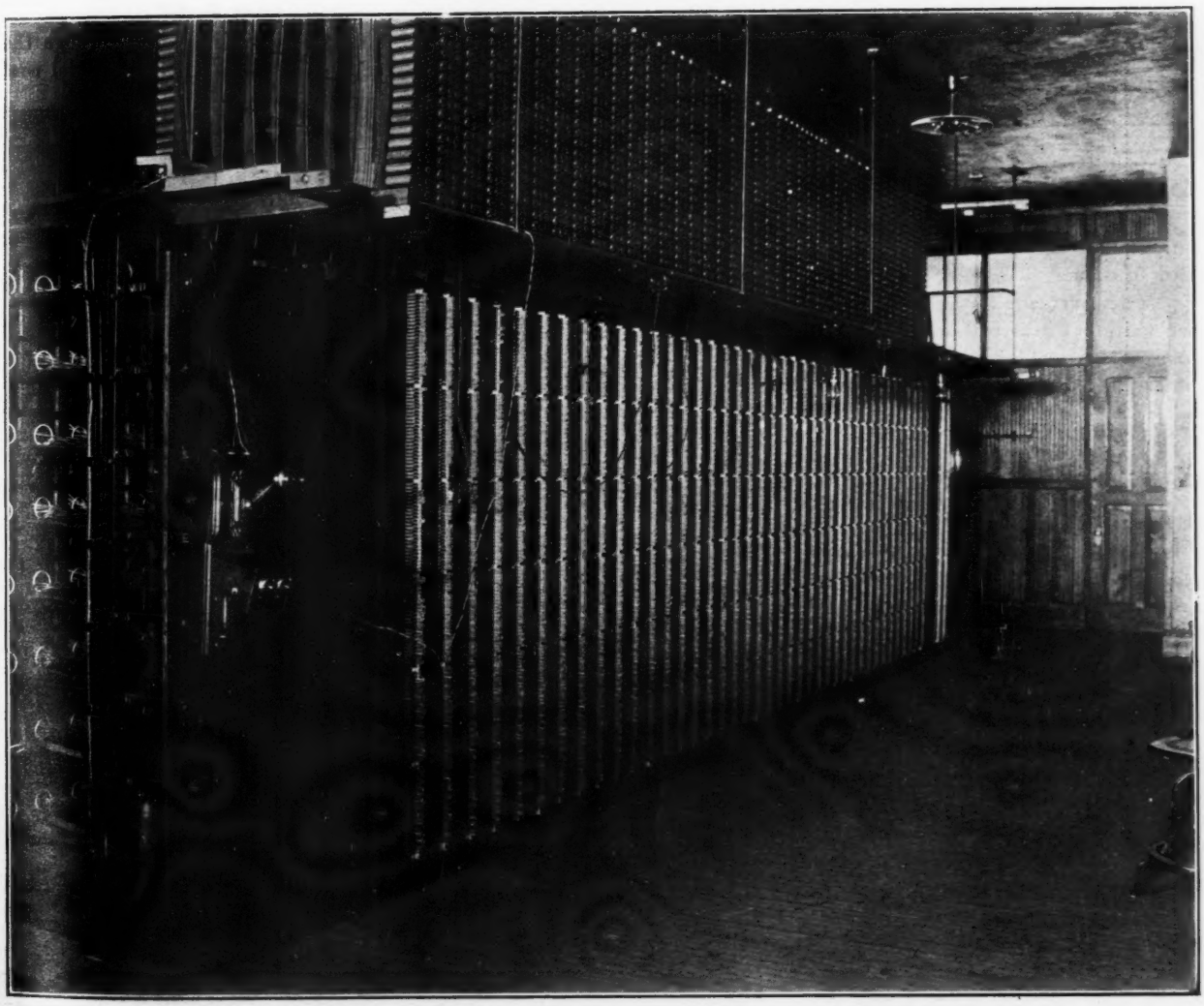
Several attempts at various times were made to rehabilitate and reorganize the older company, all of which met with failure, until early in 1901 Mr. F. G. Graves, who had received financial support that could not be questioned, began a canvass of the town, and, when 3,600 contracts had been secured, applied for a franchise. Up to this time he had had smooth sailing, but when he went before the city council he found that he had conflicting interests to meet that even the 3,600 contracts in his possession were not sufficient to overcome.

There was some talk of remuneration to the city and the obstruction of streets with two sets of poles, but the chief trouble seemed to be that the "consideration due a councilman" had been left out of the account, for "servants of the people," like servants of lesser degree, generally expect to make additions to their regular

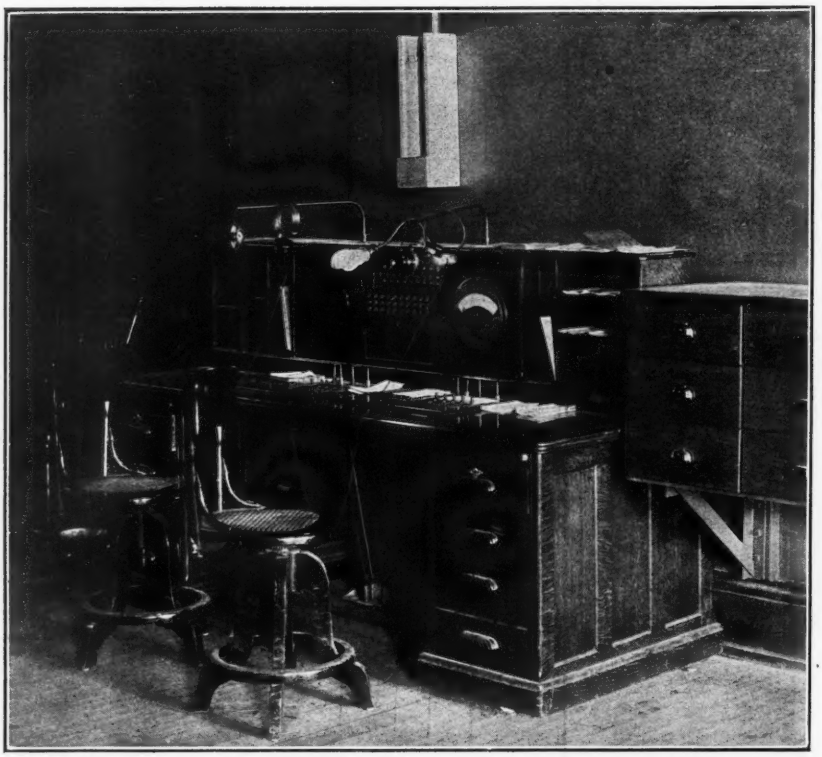


BEHIND THE MAIN SWITCHBOARD, HOME TELEPHONE COMPANY, TOLEDO, OHIO.

THE OPERATING ROOM, HOME TELEPHONE COMPANY, TOLEDO, OHIO.



THE INTERMEDIATE DISTRIBUTING BOARD AND RELAY RACKS, HOME TELEPHONE COMPANY, TOLEDO, OHIO.



THE TROUBLE CLERK'S DESK, HOME TELEPHONE COMPANY, TOLEDO, OHIO.

incomes from those they serve, and in the present case the ordinance was referred to the committee on streets and sewers, from whence it never emerged.

The state law, however, provides that if a telegraph or telephone ordinance is defeated in council it may be taken up by the probate court, and in the present case, after waiting for several weeks for the council to take action, the case was carried to the court for a mandamus compelling the council to grant the franchise.

In the hearing before Judge Millard the council was scored in the following language:

"It is unfortunate that the city council do not stop shying at their duty and leave little political discussions alone. As they have seen fit to shun their duty from whatever cause it may be, the law imposes the duty on us to supplant the common council. I think the proof is amply sufficient to grant the prayer of the petition. The only sign of life the council showed was a demand for copies of the request, and the demand seems to me an unreasonable one. It does not seem to me to show good faith. . . .

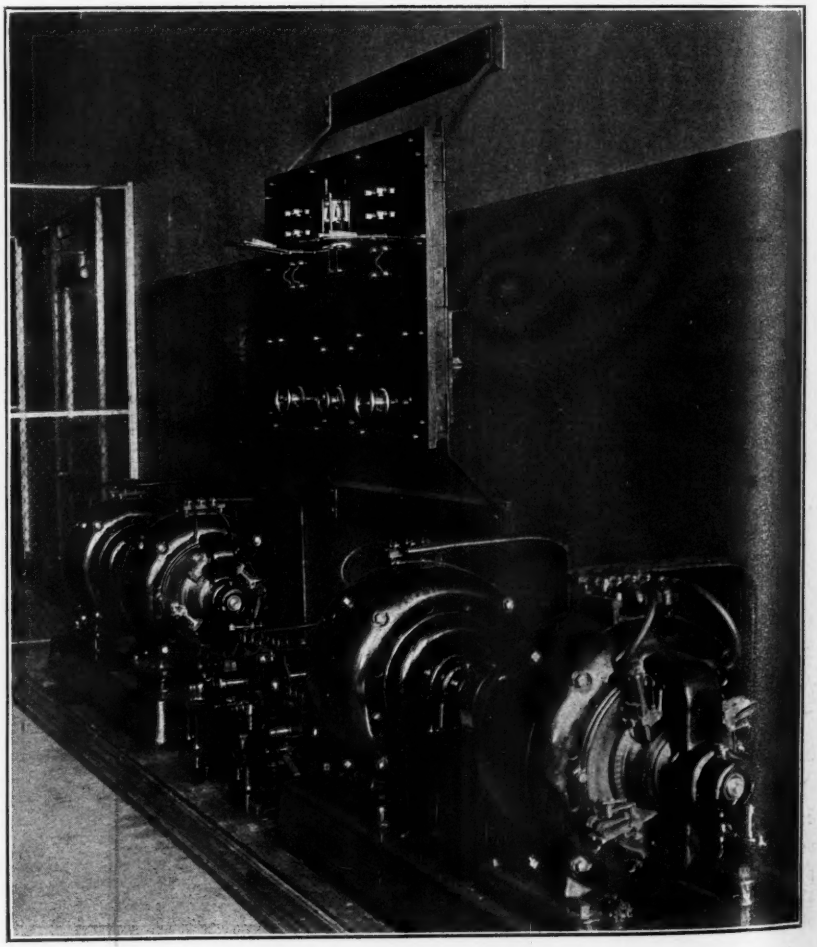
"As they had not taken the trouble to look at one copy, fifty copies would not have helped them.

"The prayer of the petition may be granted and the journal entry drawn up and approved by counsel."

Of course, the decision was freely criticised by the "grafters," and much talk of the rights of cities and a great cry for home rule, ignoring completely, of course, the rights of those who wished an improved telephone service. Besides, what is to become of councilmanic perquisites if courts are going to interfere in this manner. The council also seems to entertain the idea that, as the older company had paid nothing for its franchise originally, the surest way to encourage competition and put the two companies on an equal footing was to tax the new company well for its franchise on its account, and, in addition, to tax it the sum that the older corporation should have paid.

The decision was handed down July 12 and two days later sixty-one carloads of material had been ordered and detail work on the plans begun; one month later excavation for the subways commenced and by September 15 work on the handsome structure that now faces Huron street started.

Work was pushed all through the fall and winter as fast as material could be



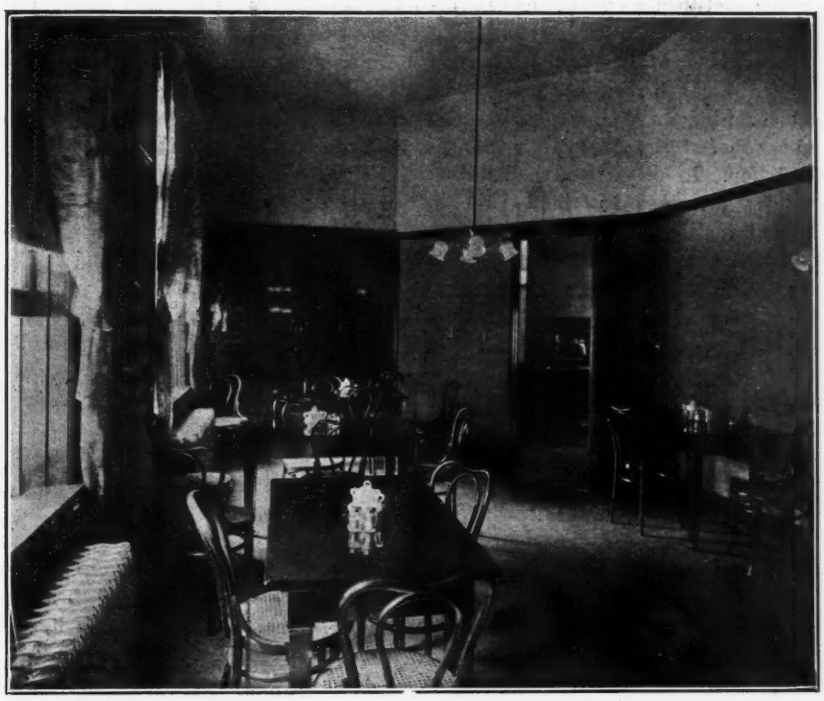
RINGING AND POWER MACHINES, HOME TELEPHONE COMPANY, TOLEDO, OHIO.

secured, and one year from the granting of the franchise subscribers were cut into the exchange, though regular service was not given till some time later.

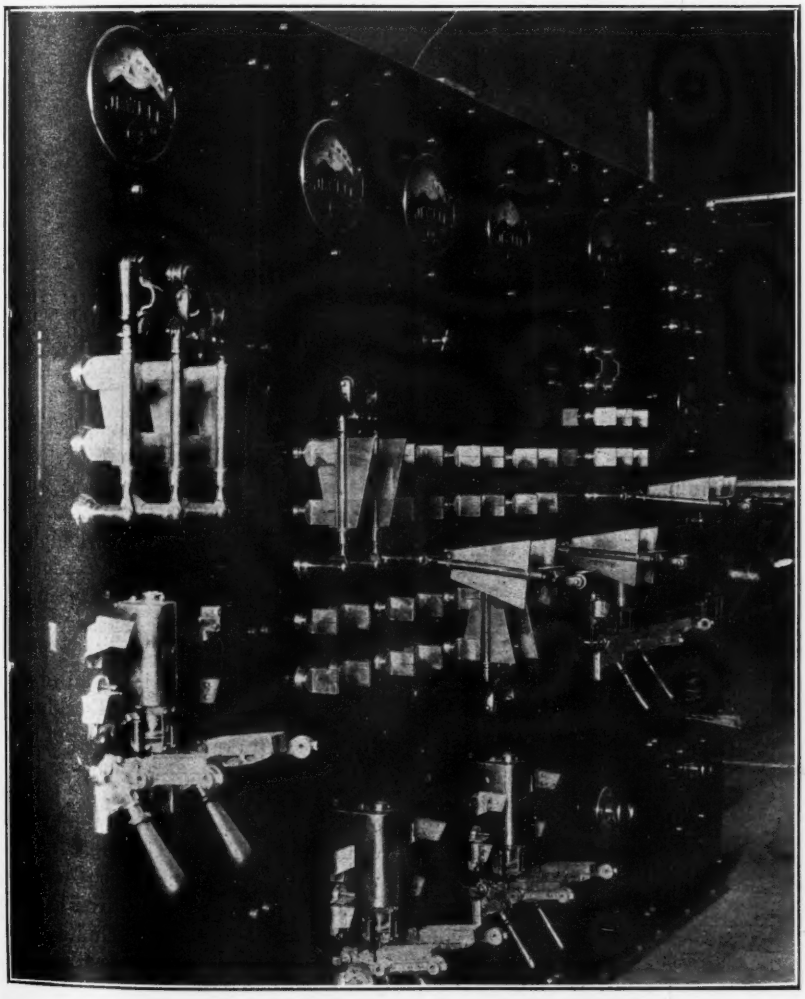
That people had confidence in the new company is proved by the fact that by the time this article is in print there will be about 5,000 subscribers connected to the exchange, as the installation goes on at the rate of 150 to 200 a week. There are also about 200 local stockholders, nearly all of the necessary capital being taken in Toledo, though outside capital stood ready to take it up. At the present rate of progress the present switchboard installation (6,000 lines) will soon have to be increased (ultimate capacity, 12,000) and more underground cable laid. There is also a second exchange in East Toledo not yet completed, with a present equipment of 900, but a possible switchboard capacity of 5,000 lines.

THE BUILDING.

The building is a handsome three-story structure composed of pressed and burnt brick, iron, cement and terra-cotta, most substantially constructed throughout, and is used exclusively for the exchange and exchange offices, and is located in the centre of the business district on the most desirable portion of Huron street. The visitor, entering from the front, enters a hallway running the entire length of the building. To the right are the auditing department and the general manager's offices, to the left the long-distance office, the directors' room, contract department and superintendent's offices.



THE OPERATORS' LUNCH-ROOM, HOME TELEPHONE COMPANY, TOLEDO, OHIO.



POWER AND TESTING BOARD, HOME TELEPHONE COMPANY, TOLEDO, OHIO.

The floor plan of the second story is the same as the first, except that there are not so many rooms, one side of the hallway being taken up with the relay and terminal room, to which all cables come from the basement, and the battery, generators, battery switchboard and battery room all within the same enclosure. On the other side of the hall is located the superintendent of equipment and draughting room, while in front is the operators' reading and lunch rooms.

The lunch-room is fitted with a pantry in which is placed hot and cold water, as well as gas ranges for heating luncheons or hot drinks. Tea, coffee and milk are furnished by the company, the operators themselves furnishing the rest.

The reading room is a cozy, well-lighted place furnished with lounges and tables for the convenience of the operators when off duty or waiting to go on.

On ascending to the third story we find two more cozy waiting, toilet and locker rooms for the convenience of waiting

operators, and then we pass into the operating room with its switchboard running all around it, or at least will when fully filled up. Light is furnished not only by numerous windows at the side, but also from the roof of glass that covers the central portion. In all parts of the building particular attention has been paid to light and ventilation, heating being furnished by means of a comprehensive hot-water system.

During the busy hours of the day more than fifty young ladies are engaged in making and answering calls, and these duty calls are made with a quiet celerity and promptness astonishing in an exchange not yet a month old.

In the central section of the room there is an information desk at which four young ladies who are supposed to know, or are at least capable of finding out, everything about the exchange or any other subject of local interest. Unnecessary to say, they are kept busy nearly all of the time. Further down the room sits the chief operator, with her assistants, who has full charge of the room, while at a desk at the extreme end sits the monitor whose whole duty consists in listening to what the operators are saying. Four other monitors patrol the room constantly to assist or advise the other operators in their work or act temporarily as relief operators themselves.

APPARATUS.

The first thing that strikes the visitor, who is permitted to look behind the board, is the absence of all relays even in the cord circuits, but on enquiring he is told that all relays are in the room below. Of course the board is of the full central energy lamp-signal type with double supervision in the cord circuit, but still the amount of wiring in connection with the switchboard seems very small.

By an ingenious arrangement all cords can be tested from the back of the board. Going down to the terminal and relay room we find a very small rack for such a large plant and are informed that there is only one relay to each subscriber's line, this one relay taking care of both the line and clearing-out signals.

The relay is, however, a double or differential one, to which battery is fed from the centre of the coil and it thus acts both as a line relay and clearing-out relay, and so combined in the cord circuit as to also act as a retardation coil. The lamps are so combined in the cord circuit that they are extinguished by being combined in multiple through the resistance of the relay, the act of hanging up the receiver releases the armature and permits the lamps to light up again.

The relay rack is placed directly over the distributing and arrester frame and is reached from a platform built for that purpose, as shown in the illustration.

The cables all terminate in the basement, but wool cable is spliced on and carried right up to the rack in the second floor where it is fanned out and soldered to the terminal clips. The rack, by an ingenious combination of clips, becomes both a cross-connecting and intermediate distributing board, the lightning arresters and heat coils being placed between the two.

Turning to the battery room we find two sets of batteries composed of six positive and seven negative plates, each fifteen inches by thirty inches, the present capacity of which is 2,000 ampere-hours, but the cells are not yet half filled with plates so that it is possible to have an ultimate capacity of 5,000 ampere-hours if needed.

The battery charging machines consist of two multipolar motor-generators connected to the 225-volt Edison mains and deliver from the generator side 250 amperes at twenty-eight volts or seven kilowatts. There are also two dynamotors used for signaling, one connected to the 225-volt mains and the other connected to the twenty-volt battery.

A large five-panel power-board allows either battery to be charged from either machine or both together, or one can be charged and the other discharged, at the same time, or both charged and one discharged at once. Underload and overload circuit-breakers take care of any accidental negligence on the part of the attendant while the battery is being charged or discharged.

OUTSIDE CONSTRUCTION.

As an illustration of the work done within the last fifteen months the following data may prove of interest:

Main line conduit, feet	280,000
Laterals, feet	5,000
Duct feet in system, feet	381,000
Pole lines, miles	150
Underground cable, miles	35
Aerial cable, miles	62
Bare copper wire	2,000
Number of poles	6,000
Number of lines in use	5,000
Number of exchanges	2
Possible number of subscribers	12,000
Possible number of subscribers, East side	5,000

Of course the construction is a mixed one, consisting of tile conduit and underground cable, aerial cable and open wire of No. 14 copper.

The poles are of Idaho cedar or Washington fir and are tall and nearly as straight as though turned in a lathe, and all neatly painted.

Distribution from the underground districts is usually made by means of poles placed in the alleys. The company also owns several miles of pole line outside the city limits.

All of the lines are full metallic circuits with no party lines in use and none contemplated up to the present time.

Mr. Robert E. Hamblin, general manager of the company, is new to the telephone field and was selected for his extensive business experience. He has had several years' experience as a banker and financier. He has, however, had considerable experience as a railway manager, being fresh from the management of the Toledo, Bowling Green & Southern Traction Company, taking hold of the road when its stock was selling around 80, but which, under his management, reached 150 in less than a year and a half. His reputation as an executive officer led the stockholders of the Home Telephone Company to make him a very substantial offer to accept his present position, and the programme for the future has been left in his hands, and, from plans disclosed to the writer, there will not only be an efficient service but substantial dividends to the stockholders as well.

This installation was equipped by the Sterling Electric Company, La Fayette, Ind.

Book Review.

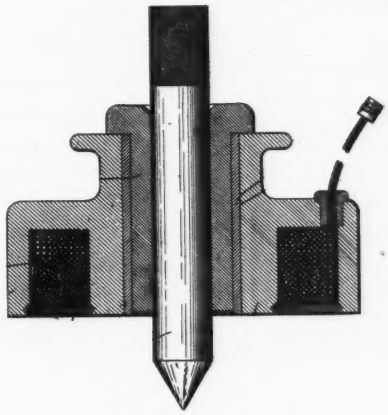
"Induction Coils for Amateurs; How to Make and Use Them." Percival Marshall. London. Dawbarn & Ward, Limited. Paper. 70 pages. 7¼ by 4¾ inches. Numerous diagrams. Supplied by the ELECTRICAL REVIEW at 25 cents.

This number of the "Model Engineer Series" will doubtless be very welcome to the large numbers of amateurs who are interested in electrical apparatus. After a brief discussion of the principles involved in the operation of induction coils, the construction of these is taken up with minute detail, and the function and use of all accessories are clearly explained. Chapter 3 describes, with detailed drawings, the construction of a shocking coil. Chapter 4 takes up the building of a half-inch sparking coil, and chapter 5 that of a four-inch sparking coil. The quantities of materials required are given. Chapter 6 discusses the use of interrupters of the various types. Dimensions for various sizes of sparking coils are given in tabular form, and the book concludes with a chapter upon experiments with this apparatus.

Electrical Patents

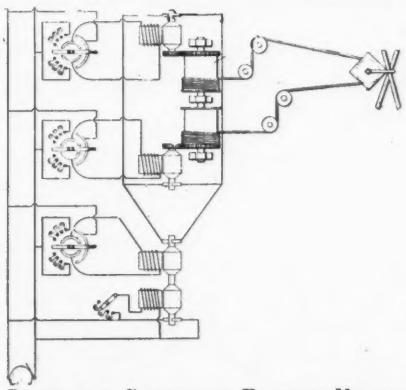
The ordinary method of securing the accurate location of a drilled hole is extremely slow and generally unsatisfactory. Usually the centre for the hole is marked with a deep centre-punch mark to receive the point of the drill, and around it is scribed a concentric circle, generally accentuated by means of light prick punch marks. The drilling is then started, and when the bits of the drill have fairly entered then the drill is removed and the work is inspected to see if the countersink produced by the drill bits is concentric with the scribed circle. Drills have a tendency to work over sidewise after being properly started, and consequently the initial work is quite apt to be excentric. To correct this, a light groove is cut down the proper side of the countersink and the test is repeated until finally the countersink is found to be concentric with the scribed circle, whereupon, carefully watching for recurring errors due to the side running of the drill, the drilling may be proceeded with. This corrective measure by grooving the countersink must be brought to full fruition before the drill enters the work the full depth of its bits. Mr. Adolph L. De Leeuw, of Hamilton, Ohio, has patented a magnetic jig which he claims will accurately guide drills in positions indicated by a properly located centre-punch mark, the jig being magnetically secured to the face of the work, and the drill being guided by a bushing therein. To this end he employs a hollow magnetic core, within which is located a fixed bushing of non-magnetic material, as brass. Another bushing is removably inserted within the non-magnetic bushing and is formed of hardened material, the bore of this latter bushing being the size of the hole to be drilled. A centre plug fits in the hardened bushing and is susceptible of movement by hand. An energizing coil surrounds the core and is encased in a metallic jacket, the whole forming an ironclad magnet with lower concentric polar faces. From the casing lead the usual flexible conductors, the terminals of which are adapted for connection with a current supply. In using the device, the centre of the desired hole is first marked with a centre punch. The jig is then set over the work with the point of the centre plug in the centre-punch mark, thus locating the jig with the bore of its bushing concentric to this mark. The current is then turned on, thus energizing the magnet and fixing the jig firmly to its work, after which the centre is removed and the drill fed through, thus ensuring a proper guide which will prevent the drill working sidewise.

Mr. Harry W. Leonard, of Bronxville, N. Y., has invented and patented an improvement in means for controlling elec-



Magnetic Drilling Jig.

tric motors, which he describes as follows: "The object of my invention is to provide a system for controlling the torque and speed of electric motors employed in power systems, and my invention has especial reference to the operation by electric power of cable, chain, belt or similar conveying apparatus employed for hauling coal, freight, etc., in such a manner that the speed and tension of the cable or similar device can be varied and in some cases reversed in direction of movement under the control of an operator. As a typical instance of the application of my invention I will describe it



Device for Control of Electric Motor.

as applied to the coaling of warships or other vessels at sea. In carrying my invention into effect I employ two dynamo-electric machines, the armatures of which are connected in a local loop, and the armature terminals of the local source are connected to the loop so that the armatures of the dynamo-electric machines will be in multiple arc relation to the local source. The local source is preferably a dynamo-electric machine which may be driven by an electric motor or other form of prime-mover. The fields of the three dynamo-electric machines have windings which are separately excited. In the preferred arrangement employed by me, one of the dynamo-electric machines connected with the work or load operates as a generator and the other operates as a motor. When my invention is applied to the driving of a cable or similar device, I provide two drums, one for each of the first-named dynamo-electric machines. These drums are driven in such direction that as one drum pays out the cable the other drum takes it up. When employed for coaling at sea, the cable from the two drums may be carried over sheaves at the mast-head of the collier and around one or more sheaves on the towing vessel which is to receive the coal, such sheaves being suitably elevated, as by means of shear poles. In coaling at sea it is important to preserve upon the cable or equivalent device which connects the collier with the receiving vessel an approximately constant tension regardless of the relative motion of the two ships. Heretofore in attempts at coaling vessels at sea by means of cables for hauling the coal in bags a cable extended from the collier to the receiving vessel and then back again to the collier, the bags containing the coal being attached directly to the cable or to a trolley moved by the cable. In these instances the cable was first moved in one direction to convey the full bags of coal to the receiving ship, and then the cable was caused to travel in the opposite direction in order to return the empty bags to the collier. In some of these attempts three cable lines were employed in addition to the tow line, the upper line being what is known as the 'sea anchor' line, the other two cable lines being the conveying cable. In all cases it is important to maintain the hauling cable at a proper tension, and, at the same time, the driving apparatus must be capable of operating the cable in either direction and at any desired speed within limits. By means of my arrangement of driving machines I not only accomplish this object, but the variation in tension on the cable due to the rolling or pitching of the vessels is automatically compensated for by the peculiar arrangement of the driving machines; that is to say, the machines are adjusted, in the first instance, to operate at a given torque and speed. When the tension of the cable varies the load on the drums will vary correspondingly, resulting in a corresponding variation in the counter-electromotive forces of the machines connected in the local loop circuit, with the result that the machine operating as a motor will automatically take a greater or lesser amount of energy, producing a corresponding variation in torque and speed, while the machine driven as a generator by the moving cable will produce a greater or lesser amount of energy, according to the speed of the cable, and thus the drums will take up and pay out the cable faster or slower, according to the variation in tension produced by the rolling or pitching of the vessels."

Reviews of Current Engineering and Scientific Literature.

Giving Concisely the Substance of Important Papers in the Scientific, Electrical and Engineering Press of the World.

Reheating of Intermediate Receivers.

This subject has been under discussion of late, so that the following experiments conducted by Professor Weighton, at the Durham College of Science, will doubtless be interesting, although the conditions were not such as to enable one to draw any positive conclusion as to the efficiency of this operation. Although the experiments were conducted with a quadruple expansion engine, but two cylinders were used. The only difference in the trials was the use or disuse of the reheating coil. Ten trials were made in all—five with the reheater and five without. In every case the total steam consumption per brake horse-power was less by one-half pound without the reheater. At the same time, the reheater gave from three to six brake horse-power extra with the same cutoff, the engine running from seven to three revolutions per minute faster. The total condensation of steam in the reheater coils was greater than the condensation in the receiver, which it was designed to prevent. The mechanical efficiency was in every case less by about two per cent when the reheater was used, a result attributed to the friction of the low-pressure piston when running drier. The tests show that by adding heat at a very unfavorable point an engine will run faster and secure a higher mean pressure, and will do more actual work, though at a less mechanical efficiency. It is to be regretted that the conditions adopted were not more nearly those to be met in practice, where the engine would be operated at a constant load and constant speed, but with variable cutoff.—*Electrical Review* (London), September 19.

The Control of Electric Motors in Factories.

In this article Mr. N. C. Woodfin discusses the difficulties met with in introducing electric motors in factories. One point made by the author is that in purchasing a motor all accessory apparatus should be included in the price quoted for the motor. The most important accessory is the starting switch, and although these at present are fairly good, they are more or less expensive and might be improved. It is thought advisable to enclose all the working parts of these switches in suitable cast-iron boxes, and thus afford protection from the weather and entirely prevent interference with the electrical conductors. Another objection is that at present the installation of a motor necessitates more or less running of circuits, installing switches and fuses and other accessory devices. This should not be the case, and all accessory apparatus should be included within the motor itself, so that to install such a motor nothing more would be necessary than to carry the two wires from the power circuit to suitable terminals on the frame. Attach these, and the motor will be ready to run. In large factories some trouble is experienced in starting up the plant after the generator has been connected to the switchboard. It usually happens that an attempt is made to start a large number of motors at the same time. This naturally overloads the generator, probably opening the circuit-breaker and shutting down the plant. This, the author thinks, might be avoided by having all the motors started from the dynamo room, and although this would involve more or less delay, it is thought that the additional safety to the apparatus would more than compensate for the lost time.—*Electrical Review* (London), September 19.

Heating of Toothed-Core Armatures.

In this article Mr. F. W. Davies examines the causes of the excessive heating of motors, which is sometimes found to be the case without any apparent reason. There are three principal sources of loss in energy in a continuous-current armature. They are: The copper loss, the hysteresis loss and the loss due to eddy currents in the core stampings. In addition to the foregoing, there are also the loss due to the short-circuiting of each coil or section of the armature while under the brush, and the loss due to eddy currents in the active conductors themselves. Unless the design of the machines is an abnormal one, these latter will be quite negligible. An abnormal temperature rise of the armature at light loads shows that the copper loss plays but a small part in the matter. The magnetic induction in the armature core proper is never very high, but the teeth are frequently made narrow, with the idea of minimizing the armature reaction, and this increases the hysteresis and eddy current losses. The loss by hysteresis varies directly as the number of cycles of magnetization, while the loss by eddy currents varies as the square of the number of cycles. Therefore the periodicity must be kept as low as possible. The periodicity varies as the speed and also as the number of pairs of poles. For this reason many of the small four-pole enclosed motors would run cooler if the magnets were of the bipolar type. Further, the polar angle embraced by one pole of a four-pole machine is slightly less than one-half of that embraced by one pole of a two-pole machine. From this it will be seen that the number of teeth embraced by the magnet pole is not exactly in inverse proportion to the number of magnet poles. For this reason the magnetic induction in the teeth becomes greater as the number of poles is increased. This effect is somewhat compensated for by the fact that the radial depth of the armature core, and consequently the radial depth of the teeth, is proportionally less for multipolar machines, and therefore the teeth will be proportionally wider at the roots. The foregoing considerations emphasize the necessity of calculating the watts lost in the armature teeth. For this purpose the mean average magnetic duction in the armature teeth may be taken as being equal to that at one-third the distance up the teeth, measuring from the roots. An offset against the increased losses in the iron, which accompany the increase in the number of poles, is the decreased copper loss in machines of this type.—*Electrician* (London), September 12.

Smoke Abatement.

At a recent congress of the Sanitary Institute, held at Manchester, England, Mr. W. N. Shaw discussed the question of smoke abatement. He drew an interesting parallel between the treatment of smoke and the disposal of sewage, and stated that in London nearly a million tons of sewage were removed day by day

from about 600,000 houses, averaging about a ton and one-half for each house. At the same time, each day in winter each house throws into the atmosphere on the average, perhaps, ten tons of smoke-laden air, or a total of 5,000,000 tons of smoke-laden air for the inhabitated houses of London per day. That was his estimate of the amount of refuse which is thrown into the London atmosphere. The actual weight of solid soot was uncertain, but might, in the worst cases, amount to nearly three per cent of the coal consumed. The houses of London probably get rid of 300 tons of refuse per day by throwing it up the chimney. The difference between the removal of smoke and the removal of sewage lay in the fact that the sewage went down, while the smoke went up. The author did not suppose it was possible to establish a few main drains for smoky air, as a rough calculation had shown that for London this would require some forty tunnels of the size of the underground railway tunnels. The system, however, might be applied on a small scale. A single block of houses might have means for drawing off smoke from all its fires into a chamber, where it could be treated to remove the soot. Some years ago Sir Oliver Lodge showed experiments of the deposition of smoke in a closed chamber by means of electricity. It is suggested that further work in this direction might give some valuable results. Mr. Peter Spence's proposal for the erection of municipal chimneys was mentioned, and the author expressed the confident opinion that the science of the twentieth century could give as satisfactory an answer to the question of the treatment of smoke as the science of the nineteenth had given to the treatment of sewage.—*Engineering* (London), September 19.

Water-Power Developments Around Ottawa.

In the second section of this serial are described several interesting power plants in this vicinity. The Bronson Carbide Company has a very pretty development, operating under a thirty-five-foot normal head. In each of the two flumes is set two pairs of horizontal fifty-inch Samson wheels, coupled together. The extended shaft passes through the wall of the power-house and is connected to the generator shaft. The two pairs of wheels run at 163 revolutions per minute, and when the head is reduced to the minimum of twenty-five feet, each set is capable of delivering 2,000 horse-power to the generator shaft. Each set of wheels drives a 2,000-horse-power, single-phase, sixty-cycle generator, delivering current under a pressure of 2,300 volts. To the end of the generator shaft is coupled a 250-horse-power, direct-current, 220-volt generator, serving both for excitation of the main generators and for the operation of the direct-current motors in the carbide works. This arrangement was adopted to avoid the use of polyphase alternators for operating the furnaces. The power-house is spanned by a thirty-ton Whiting hand-power crane, and is lighted by arc lamps. At the Deschene Rapids, about seven miles above Ottawa, on the Ottawa River, are located the power plants of the Hull Electric Light Company, Hull & Aylmer Railway Company, the Deschene Electric Company and the Conroy power plant. The natural fall of the river is handled without a dam. The head of the water is about nine feet. The buildings occupy two sides of a square, the intake and shore forming the other two sides. In the wheel-house, running parallel to the flow of the river, are six seventy-two-inch new American wheels. These drive through gears on the main shaft, tying all together into a single unit to drive an 800-kilowatt generator. The second wheel-house contains pits for five wheels, which will be geared up in the same manner. These generators are three-phase machines, running at 180 revolutions per minute, and give sixty cycles. They are wound for 11,000 volts, and have a capacity of forty-six amperes per phase at full load. High-voltage oil-break switches are provided at the switchboard and are enclosed in brick walls, but operate in the front of the switchboard by the usual hand lever. There are two three-phase lines of No. 2 bare copper wire, one on each side of the poles. The telephone line is carried on a two-pin arm below the power circuits and transposed at every sixth pole. The transformer substation is located near the Eddy company's paper mills. Here the voltage is stepped down by means of oil-cooled transformers to 400 volts for use in the induction motors driving the paper mills. The motors range in size from 20 to 300 horse-power.—*Canadian Engineer* (Montreal), October.

Electrometallurgical Problems.

This is the first of a series of articles on electrometallurgical operations, and in it Mr. A. A. Beadle discusses copper production and refining. There are eleven important copper-bearing minerals, the principal of these being unoxidized ones. The oxidized minerals are easily reduced by ordinary metallurgical processes, and need hardly be considered. The unoxidized ones present great difficulties. In the usual treatment adopted, seven operations are required, though these may be reduced to five if the matte is treated in the Bessemer converter. Electrometallurgical methods come under two heads—those in which copper is obtained in solution from the crushed ore and then deposited electrolytically, the solution being regenerated by further treatment of the ore. In the second class, the copper ore is used as an anode, and the metal is dissolved and electrolytically deposited in a more or less pure condition on the cathode. The first attempt to treat these ores is due to Body, who crushed the ore and placed it in an electrolyte of ferric salt and sodium chloride. Siemens & Halske followed this process, but gave a preliminary roasting to the ore. Hoepfner followed the same plan, but used an electrolyte of cuprous chloride. All these methods belong to the first class. An attempt coming under the second class is due to Marchese, who cast the ore into plates and electrolyzed these, using a high potential. None of these methods has been entirely successful. The author suggests the use of nitrate of copper as an electrolyte. The nitrate is by far the most soluble salt, and has the highest safe rate for deposition. From this solution the metal can be deposited in a smooth, tough form at a current density of forty amperes per square foot. This was from two to four times that usually adopted in copper refining. As all nitrates are soluble, to secure a pure deposit a small amount of chloride or sulphate of copper may be added to the electrolyte, and this will precipitate other metals which are undesirable. The pressure required in this operation is from three to four volts per vat. This is caused by the high resistance of the impure anodes. The reduction of copper from its fused salts does not promise to be of value on account of the high melting point of the metal. Further, copper and iron sulphides in a fused condition behave more as a metal than an electrolyte. It is possible, however, to reduce the sulphide electrolytically in the presence of some fused fluxes.—*Electrical Review* (London), September 26.

Reliability Contest for Automobiles.

Seventy-five automobiles started in the 500-mile reliability contest between New York and Boston. The only electric machine entered retired soon after leaving the first noon control.

INDUSTRIAL SECTION.

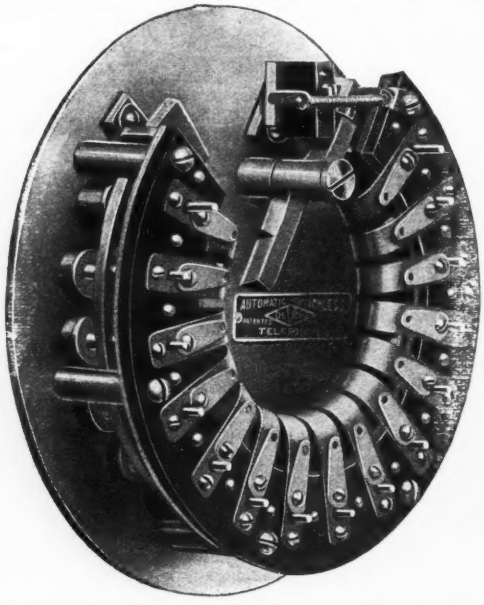
ILLUSTRATED DESCRIPTIONS OF NEW AND STANDARD ELECTRICAL AND MECHANICAL APPARATUS.

A New Automatic Switchless Telephone.

For many years it has been the object of telephone manufacturers to devise a simple intercommunicating telephone for office and house use which would give good service and yet not be so complicated as to make it liable to rapid deterioration from wear. Many devices have been designed to accomplish this and have met with more or less success in this direction. Such troubles as cross-talk or rapidly exhausted batteries, however, have been the means of bringing disaster to many well-thought plans, and it has required the constant effort of the inventor to bring out a finished product which would eliminate these difficulties.

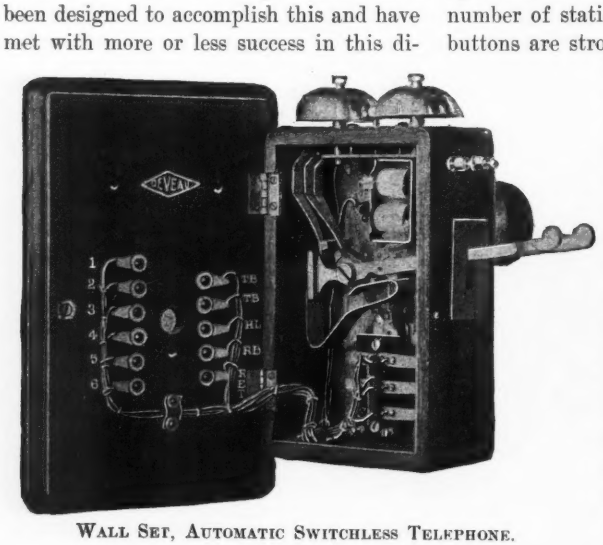
The De Veau Telephone Manufacturing Company, of New York city, has recently placed upon the market an intercommunicating telephone which is claimed to very cleverly overcome all of these difficulties. The operation is essentially as follows: In the first place, the movable switch or plug has been replaced by a set of buttons to coincide to the number of stations of the system. These buttons are strongly mounted on a metal frame and perform two functions. First, when one is pressed, it closes the ringing circuit at the station desired, causing that bell to ring. When, however, the finger is removed from the button, it does not come out the full distance, but only far enough to break the ringing circuit, it being held down against the talking circuit by a metal shoulder which does not release it until the receiver is hung up, when the mechanism automatically releases it and the circuit returns to normal. An additional and novel feature of this system is that by pressing the various buttons of several stations at once, simultaneous conversation can be carried on between them, thus enabling the various offices of an establishment to discuss any question as well as if gathered together in one room.

The De Veau Telephone Manufacturing Company is supplying these telephones in both wall and desk sets, and is in receipt of many testimonials which speak well for the popularity of this apparatus. The company has also a very complete line of long-distance telephones and switchboard apparatus, both for magneto and common battery systems, which is very popular with the trade.



SHOWING THE BACK OF THE AUTOMATIC SWITCHLESS TELEPHONE.

THE AUTOMATIC SWITCHLESS TELEPHONE.



WALL SET, AUTOMATIC SWITCHLESS TELEPHONE.

DESK SET, AUTOMATIC SWITCHLESS TELEPHONE.

Alternating-Current Generators.

Where alternating current has been decided upon as the proper means of transmitting energy, the merits of a good generator require careful consideration. The essentials are graded in the following order: Reliability, regulation, simplicity, economy and reasonable cost. The first two requirements enable the station to fulfill its most important duty; that is, to deliver its output at the proper pressure at all times. The remaining requirements enable it to do this at a maximum convenience and economy.

It is the opinion of the manufacturer of the machine shown in the accompanying illustrations that to meet these requirements demands an inductor alternator. An inductor alternator is one which has no moving wire, the rotating part being simply a rigidly constructed mass of iron as simple and durable as a flywheel. This makes all of the wire winding of the machine stationary, and it is therefore relieved of all mechanical stresses, which are the most serious sources of deterioration in dynamo insulation. The inductor machine, therefore, realizes simplicity and reliability to a very great degree.

Fig. 1 shows the frame and windings of a 150-kilowatt generator of the inductor type. Fig. 2 shows the rotating part of a sixty-cycle alternator, and it is plain that such a member can be put in a machine and rotated at almost any desirable speed with a sense of security that nothing will happen to it. The office of the inductor is to distribute the magnetic flux in and out of the generating coils at the proper time. It must therefore be heavily magnetized, and this is done by surrounding it with a single large coil in the centre recess provided for that purpose. This coil, which is shown in Fig. 3, and the position of which is clearly indicated in Fig. 1, is perfectly stationary, and is held in the main frame of the machine by means of the projecting lugs. The coil is mounted upon a continuous metallic frame, which acts as a support and also forms a closed secondary, which, by its reaction when the field coil is broken for any reason, prevents dangerous surges of pressure which might break down the field coil. It is wound upon a spool, the cylinder of which is of heavy copper to cut down the inductive rise of pressure on opening of the field circuit, the sides of the spool being perforated to allow the ventilation of the field windings by the currents of air set in motion by the poles of the inductor. The important feature of the field coil and its position with relation to the inductor is the fact that it is symmetrically placed thereon. This obviates any disas-

Fig. 1.—Frame and Winding of a 150-Kilowatt Inductor Type Generator.

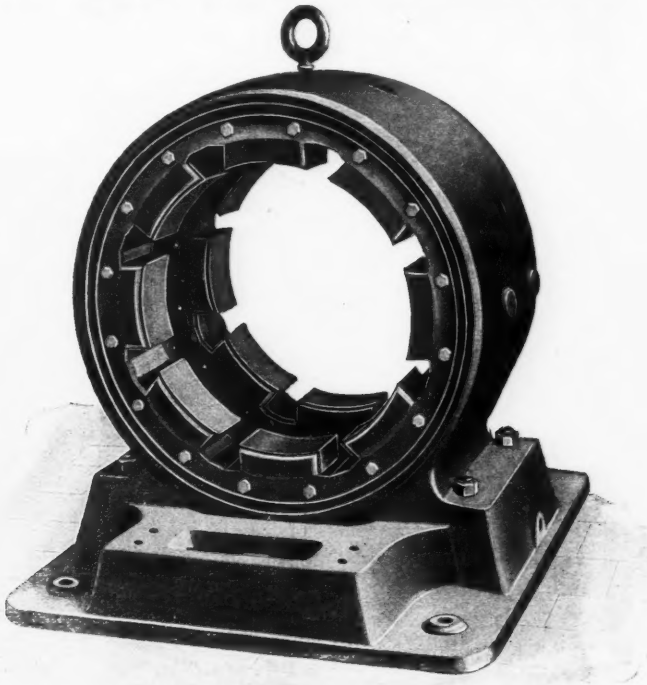


Fig. 4.—Showing Tooth Construction of Armature.

Fig. 2.—Rotating Part of Inductor Type Generator.

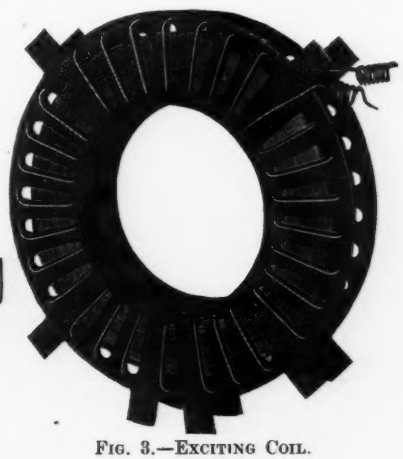


Fig. 3.—Exciting Coil.

trous side pressure, as the pull is balanced in every direction and requires no thrust bearing to offset an inclination in one direction or another.

In Fig. 4 is shown the tooth construc-

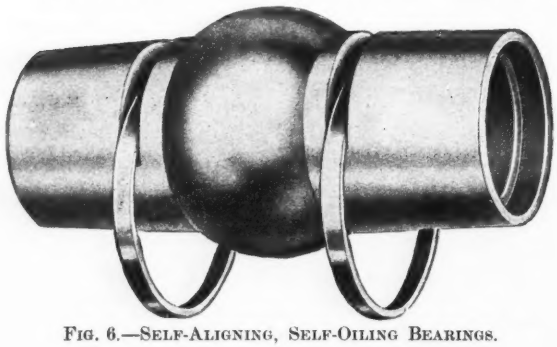


FIG. 6.—SELF-ALIGNING, SELF-OILING BEARINGS.

tion of a seventy-five-kilowatt, sixty-cycle generator. The construction of these teeth is such that each coil is separately removable and does not overlap in any way, so that if a coil is damaged it can be removed without disturbing the others, a feature which is of considerable importance when a prompt repair becomes necessary. The large dimensions of the slot also allow of ample insulation, and this feature is so pronounced that the company claims to be able to guarantee a machine generating 10,000 volts, which can be connected directly to a transmission line without step-up transformers. The high-voltage terminals of the machine are brought out to a marble terminal board, securely bolted to the side of the machine and fitted with a cover to

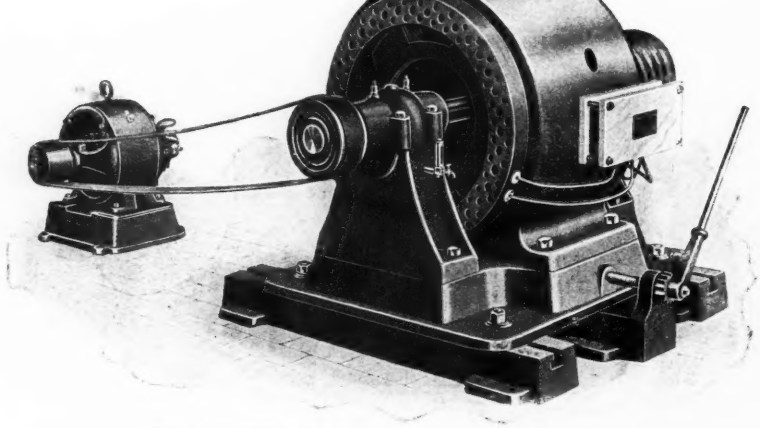


FIG. 5.—100-KILOWATT ALTERNATOR AND EXCITER.

prevent accidental contact therewith. This is well shown in Fig. 5.

In Fig. 6 is shown the general style of self-aligning and self-oiling bearings used in these machines. These are of ample size to ensure cool running under all conditions of load.

The magnetic circuit of this machine is called particular attention to by the manufacturer, and the claim is made that ninety per cent of the iron is never subjected to a change in the direction of the magnetic flux. Where this change occurs, there is a genuine loss of power, which, like all other losses, turns to heat and must be dissipated rapidly in order that the insulation may not be overheated. The amount of iron that is subjected to an intensely varying flux in this alternator comprises only the teeth of the armature and the inductor. The further refinement of the iron loss is obtained by means of lamination of the teeth, which eliminates any current losses. A careful selection of the iron further reduces hysteresis losses, due to the magnetic friction of the iron particles under the varying flux.

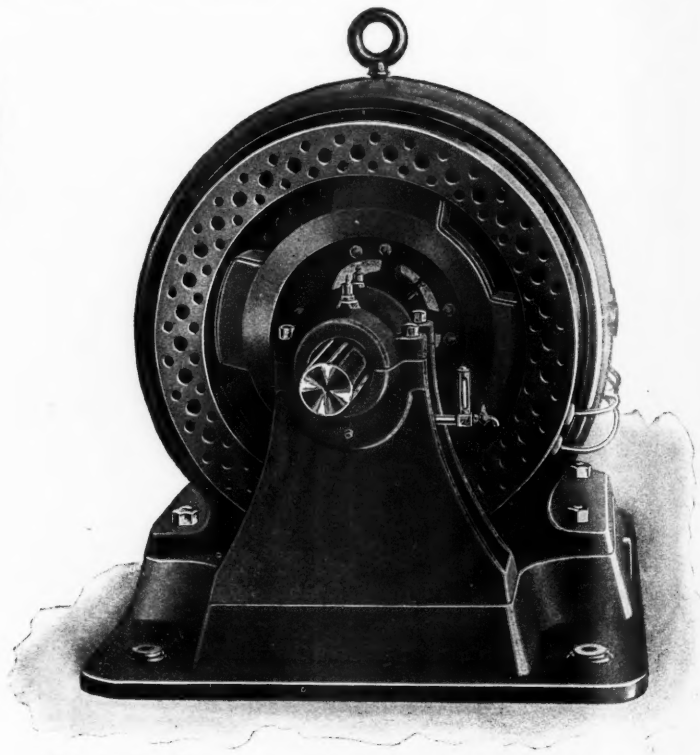


FIG 7.—END VIEW THROUGH INDUCTOR OF 75-KILOWATT ALTERNATOR.

The armature punchings are held together by substantial bolts, which secure them rightly in the supporting frame. The inductor punchings are dove-tailed into the structure. The block of lamina is thus tightly held in place, and is practically one piece with the revolving part.

The field coil is circular in form, surrounding the maximum amount of iron with the minimum length of wire. The construction enables it to be wound in such a way that the copper losses in this coil, energy supplied by the exciter, is exceedingly small, it requiring eight amperes at fifty volts to excite a 150-kilowatt alternator.

The armature coils are rectangular in shape, and present peculiar facilities for rapid repair should this become necessary. These coils are in two sets on either side of the field coil, and may be connected in multiple or series, as desired. Thus, if one side of the machine should completely burn out, the other side would still give its full output at the proper pressure, the two sides being independent of each other. Connected in series, the machine becomes a double-voltage machine, and will supply current at two pressures. As may be seen from Fig. 2, the inductor may be taken apart by the

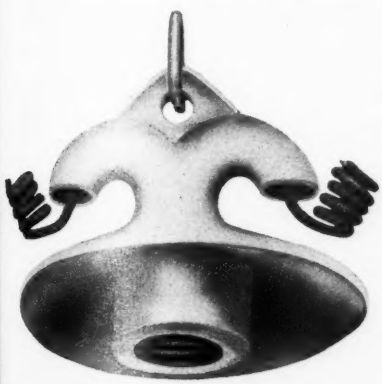
removal of a few bolts. This enables the machine to be dismounted from either side, which is an important feature in alternator construction, allowing the use of a continuous surrounding armature ring without machine joints, rendering the armature coils readily accessible.

This alternator is possessed to a high degree of inherent regulation, and the difficulties which ordinarily obtain in alternating-current machinery are claimed to be satisfactorily eliminated by proportioning the field magnet so that a heavy armature reaction displacing any phase fails to have very much impression upon it. The inherent regulation of this alternator is claimed to be from six to ten per cent, according to the size of the machine.

The Royal Electric Company, of Peoria, Ill., is prepared to build these machines for any frequency and voltage of either the belted or direct-connected type. Standard sizes are built for a frequency of 7,200 to 16,000 alternations per minute, and can be connected for 1,100 or 2,200 volts. The same machine can be wound for long-distance transmission up to 10,000 volts.

Combination Socket and Hood for Incandescent Lamps.

Among the many novelties which are being placed on the market by the Kinsman Electric and Railway Supply Company, of New York city, is a weather-proof combination lamp-holder and hood shown in the accompanying illustration. This lamp-holder is made of porcelain and is so constructed as to fit any Edison base.



Combination Socket and Hood for Incandescent Lamps.

It is adapted for outdoor work, or any place where protection against atmospheric conditions is necessary. The lamp screws tightly into the receptacle and makes contact with the terminals which enter the holder in such a manner as to obviate the reception of moisture. The appearance of the holder is very much the same as a petticoat insulator, and the flange is so arranged that any moisture will drip off and away from the widest part of the bulb.

Electrostatic Ground Detectors.

The electrostatic ground detector recently placed on the market by the Fort Wayne Electric Works, is an exceedingly simple instrument and possesses many features of merit, and in theory also differs somewhat from other ground detectors.

In all types of electrostatic ground detectors the principle of the electrostatic voltmeter is employed, the deflecting torque being created by the attractive

New Type Electrostatic Ground Detector.

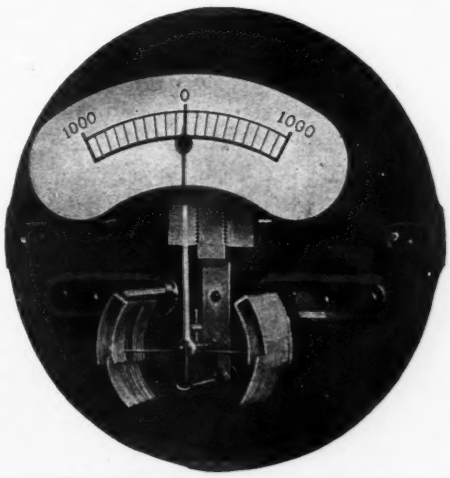
force between electrically charged surfaces. In most single-phase ground detectors the line terminals are connected to two plates, or two sets of plates, which are stationary, while the movable plate or vane is connected to earth. When no ground exists, the movable number is attracted equally by the two stationary parts connected to opposite sides of the line, but as soon as one side of the line is connected to earth or grounded, the partial neutralization of the charges on the movable vane and the grounded line produces an unbalanced condition between the attractive forces of the two stationary plates and the movable vane and causes a deflection of the pointer attached to the vane toward the grounded side. The amount of the deflection indicates the strength of the ground, a direct ground throwing the pointer to the limit of its motion in the direction of the grounded side, while a leakage or partial ground is indicated by a slight deflection.

In the Fort Wayne single-phase electrostatic ground detector the line terminals are connected to stationary members composed of sheet aluminum stamped and pressed into shape not unlike a double rake with curved, pointed teeth. The charge produced by the line potential is concentrated on these points according to a well-known law of electrostatics. The movable member consists of two similar sets of points carried on opposite ends of an arm mounted on a shaft set in jewel bearings. These points are free to move in or out between the double sets of stationary points. The moving parts are in no way connected to the circuit, but receive their charge from a set of points that are charged by another group directly connected to the earth. A delicate torsion spring connects the shaft to these stationary points and together with a light, adjustable weight on the shaft, maintains the pointer at zero position under normal conditions.

The application in this instrument of the theory of the concentration of an electric charge at a point makes practical the use of an extremely light moving part, which is still further lightened by making it of aluminum. The result is a sensitive instrument whose accuracy is permanent since wear on jewels or shaft is inappreciable.

The entire mechanism of the instrument is rigidly mounted on and thoroughly insulated from a solid metal base, which is designed for mounting on switchboards. The cover is easily removed without disturbing the adjustment or connections which are all made from the back. The scale is silvered brass, mounted in the top of the case similarly to other round switchboard instruments. The middle of the scale is zero, or "no ground" position of the pointer.

The instrument is connected perma-



New Type Electrostatic Ground Detector.

nently in circuit through graphite sticks carried on hard rubber insulators mounted on a marble base designed for mounting on the back of the switchboard.

The resistance of these graphite sticks is sufficient to protect the instrument and the circuit from accidental grounds or short-circuits within the instrument itself.

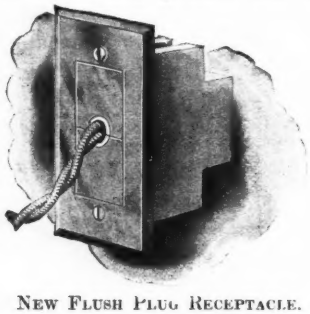
These ground detectors may be used on

two or three-phase circuits, two instruments being required in either case. For two-phase, two-wire circuits two ground detectors and two sets of three graphite resistances are employed, while but one set of four resistances and two instruments are necessary for two-phase three-wire or three-phase circuits.

The design and construction of these ground detectors are of the highest order. They are furnished with either polished brass or oxidized finish to conform to other standard switchboard apparatus.

New Flush Plug Receptacle.

The new flush plug receptacle shown in the accompanying illustration is one of the most recent productions of the Marshall-Sanders Company, of Boston, Mass. This was designed in order to provide finished outlets in the doors and baseboards of large office buildings so that lights could be provided for desk sets in almost any position and at the



NEW FLUSH PLUG RECEPTACLE.

same time to correspond with the fittings and finish of the rooms. The plug and receptacle are made of porcelain and brass and is amply heavy for the current usually required. The receptacle fits the standard box for push-button switches of all manufacturers. This receptacle is literally flush whether in or out of service, the two lids closing tightly around the cord when the plug is within the receptacle.

An Excellent Publication.

The E. L. Powers Company, publisher, of New York, has issued a "Pocket List" of the electric railways of North America. It is aimed to give in this form quarterly a thoroughly correct and up-to-date list of the street railways, with information in detail concerning their capital, equipment, length of track, etc., and the names and addresses of officials. This "Pocket List" will be issued as a supplement to the regular edition of the well-known "Street Railway Directory and Buyers' Manual," published by the same house. It covers the street railway interests of the United States, Canada, Mexico and the West Indies.

The book is compactly got up, and will be a valuable and convenient reference. It is sent free to all advertising patrons of the directory.

Novelties in Line Material.

The accompanying illustrations show a few of the specialties manufactured by the Billings & Spencer Company, Hartford, Ct. Fig. 1 is a new type insulating stud which is used in many forms

FIG. 1.—INSULATING STUD.

of hangers designed by this company. It has been impossible to determine the tensile strength of these studs owing to the fact that in all tests which have been made the threads were stripped from the studs at a strain of from 15,700 to 16,000 pounds without the slightest injury to the

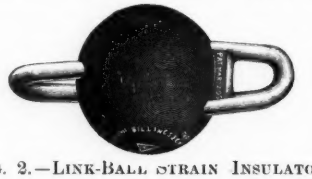


FIG. 2.—LINK-BALL STRAIN INSULATOR

insulation. The crushing strength is 40,200 pounds. The middle part is of drop-forged steel, threaded five-eighths inch U. S. S. and provided with a hexagon head. Fig. 2 represents a link-ball strain insulator. The links and discs are forged of the best steel for this purpose and the diameter of insulation is

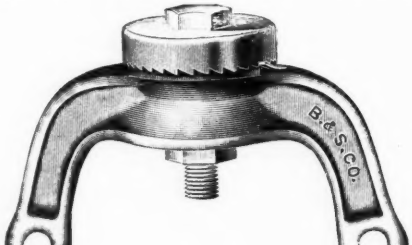


FIG. 3.—DOUBLE ARM TROLLEY HANGER.

two and one-half inches. This link has become very popular, and the company is meeting with a great demand for such material.

Fig. 3 is a double curve hanger which is made of bronze, malleable galvanized iron and is fitted with an insulated conical five-eighths-inch drop-forged steel stud.

Independent Telephone Association of Southern Indiana.

The annual meeting of the Independent Telephone Association of Southern Indiana will be held in Louisville, Ky., October 28 and 29, 1902. The officers of the association are: G. A. Kienle, president; C. D. Knoefel, vice-president; E. W. Packhardt, secretary, Huntingburgh, Ind., and T. H. Thom, treasurer.

New York Electrical Society.

The New York Electrical Society will open its 1902-03 season on Wednesday, October 22. This, the 227th meeting of the society, will be held, by courtesy of the American Institute, in the lecture room of the Institute at No. 19 West Forty-fourth street. Mr. Charles R. Pratt will lecture on "Electric Elevators." The lecture will comprise a brief history of electrical elevators, the present state of the art, and what is being done toward developing a high-speed electric elevator. The lecture will be freely illustrated with lantern slides.

President Sheldon has appointed the following committees: Finance—H. A. Lardner, chairman; G. Herbert Condict. Membership—W. S. Barstow, chairman; C. O. Baker, Jr., Willard S. Bennett, Reginald Pelham Bolton, E. H. Mullin and C. L. Wilcken. Examining—H. V. A. Parsell, chairman; W. I. Donshea. Reception—Hobart D. Betts, T. C. Martin, H. A. Sinclair, G. H. Guy. Papers and meetings—G. H. Guy.

There are already a large number of applications for membership to be presented at the opening meeting. The society commences this season under highly favorable conditions, both as to membership and finances.

Purification of Water by Ozone.

An examination of the results obtained in the purification of water by treatment with ozone has just been concluded by Drs. Ohlmuller and Prall, on behalf of the German imperial health department. The apparatus used was capable of treating ten cubic metres of water per hour. The water was sprayed through a rose to a bed of pebbles, beneath which ozonized air was forced under pressure. The down-flowing water thus came into very intimate contact with the up-flowing current of air. Bacteriological examinations were made both before and after treatment, while the effect of the process on the color, clearness and taste of the water was also observed. The bacteria which survived appeared to be of a specially resistant type, since their number was not reduced by prolonging the ozonizing action. It was found that the whole of the pathogenic bacteria were entirely destroyed by the process. None of the germs of cholera or typhus species survived. The process improves the color of the water and has no bad effect on the taste. The cost is given at about five cents per thousand gallons, one-third of which represents the actual cost of ozonizing.

The Specific Utilization of Materials in Dynamo Design.

At a recent meeting of the British Association, Professor S. P. Thompson discussed the considerable differences found in machines designed for the same purpose by different engineers. In one case the magnetic saturation would be high, in other cases the current density of the conductors would be high. The consideration of the subject is limited to the armature, and the problem is attacked by making use of the conception of the "active belt" as defined by Mr. Mavor. This term is used to define the entire mass of the peripheral structure of the armature, down to the roots of the armature teeth.

In Mr. Mavor's paper the supposition was made that in all machines the field was equally strong, and the peripheral speeds alike. In this way he ascertained for a number of different machines the number of ergs per second per cubic centimetre of active belt at unit velocity in unit field. In this study, the author extends the conception of the active belt, and considers the various flux densities used and periphery speeds.

Direct-current machines only are considered. Examination of the operation of any armature shows that the output may be decomposed into three factors. One of these is the gross current density per square inch in the active belt, assuming a uniform distribution of current throughout this area. The second factor is the gross magnetic density per square inch, radially, in the active belt; and the third factor is a quantity proportional to the peripheral velocity. The specific output of any machine is therefore proportional, in watts per cubic inch of active belt, to the product of these three factors. The gross current density in the machines examined, which were all of modern designs and of sizes over fifty kilowatts, was found to lie between 300 and 400 amperes per square inch.

The gross magnetic density was found to be generally between 30,000 and 40,000 lines per square inch; while the third factor lies mostly between 0.000005 and 0.000009, corresponding to peripheral speeds of between 2,000 and 4,500 feet per minute. In the machines considered, the specific output was found to vary between 45 and 120 watts per cubic inch.

In one case the value was as low as fifteen watts per cubic inch, though the machine was by a first-class maker. Another exception was a 1,600-kilowatt generator, which had a specific output of 192 watts per cubic inch. Attention is then called to the unnecessary restrictions sometimes imposed by consulting engineers, particularly in reference to the allowable temperature rise in generators.

PACIFIC COAST ELECTRICAL NOTES.

NEWS OF WESTERN ELECTRICAL DEVELOPMENTS.

The Oriental and Occidental Steamship Company, with headquarters in this city, is now arranging to replace the mechanical telegraph systems of its transpacific steamers with electric telegraph systems. The electric apparatus is being shipped out from England. The work will be done at the Risdon Iron Works under the direction of Mr. Roxburgh, the electrical engineer for the latter company. The steamer Doric which will be the first transpacific liner equipped with electric telegraph, is now in charge of Mr. Roxburgh.

Mr. Benjamin M. Maddox, of Visalia, Cal., succeeded A. G. Wishon as vice-president and manager of the Mount Whitney Power Company, of Visalia. Robert McF. Doble, Hayward Building, San Francisco, has been appointed consulting and supervising engineer. Mr. Doble reports that a number of improvements and extensions in the distribution system are to be made. The construction of power-house No. 2 will also be undertaken. Surveyors are now at work on these proposed improvements. The new power-house is to be located on the north side of the Kaweah River about two miles below power-house No. 1. It will be run in multiple with power-house No. 1. The water for the operation of power-house No. 2 will be taken from the middle fork of the Kaweah. The equipment will consist of two 350-kilowatt generators, with tangential water-wheels, direct-connected and operated under 340 feet of effective head. Work is now in progress on the hydraulic end of the construction and specifications for the electrical machinery are now ready, though no contracts have yet been let. The plant will embody some new features, particularly in the direction of simplicity, and in the matter of high quality of installation.

The Stanislaus Mill and Power Company, of Knights Ferry, Cal., is preparing to put in new wheels. Two Victor turbines will be used as auxiliaries. W. H. Allen, 331 Pine street, San Francisco, is the consulting engineer.

The Consumers' Electrical Association, 524 Sutter street, maker of electrical specialties, is now fitting up a complete electrical hospital apparatus for the new hospital of the United Railways of San Francisco. The apparatus includes a large special wound coil, for taking X-ray pictures and views of the human body. The coil is a fifteen-inch spark Rhumkauff. There will be three large, complete switchboards, suitable for administering the proper currents for galvanic, faradic, sinusoidal and cautery currents. There will also be surgical motors and vibrating massage instruments.

The McCloud River Electrical Power Company, A. F. Johns, Redding, Cal., general manager, has bought all the water rights, rights of way and other interests of the Shasta Electric Power Company. A 1,000-horse-power steam electric plant is to be put in at Kennet, Shasta County, Cal., to furnish power for the proposed electric line connecting the large mines of that district with the railroad. The McCloud River Company has increased its capital stock from $1,500,000 to $3,000,000.

Articles of incorporation of the Home Telephone and Telegraph Company were filed in this city on September 20. This company has secured a number of franchises in various parts of the state. Plans are under way for the construction of telephone lines from San Diego, in Southern California, *via* Los Angeles, Bakersfield and Fresno to San Francisco. Shorter lines are to be constructed from Los Angeles to San Bernardino and at other points. Later a line will be run from Los Angeles *via* Ventura, Santa Barbara, San Luis Obispo, and Salinas to San Francisco.

The Cœur d'Alene, Idaho, Electric Light and Water Power Company, whose power plant at that point was recently burned, has contracted with S. A. Barnan, of Cœur d'Alene, for the construction of a brick building forty by seventy feet with full stone basement and composition roof, to be practically fireproof throughout. New boilers will be put in for driving the company's two seventy-horse-power engines. Dynamos with a capacity for furnishing 1,200 lights are now in transit from the East.

A franchise for an electric lighting and power system has been granted to W. W. Barnes and J. T. Coffman by the supervisors of Santa Barbara County, Cal. Power and light will be supplied to the Santa Maria and Lompoc valleys, as well as to the towns of Lompoc and Guadeloupe. Generating stations will be erected at Lompoc and at Santa Maria. The headquarters of the company are at Santa Barbara. A. P. B.

San Francisco, October 3.

CURRENT ELECTRICAL NEWS

DOMESTIC AND EXPORT.

A NEW BRAZILIAN TRACTION SYSTEM—The city of Santos, Brazil, is to have an electric traction system operated by American equipment. The initial length of the road will be about ten miles. The power-house equipment will consist of two generators of 200-kilowatt capacity, each direct-coupled to 300-horse-power engines.

MOZAMBIQUE TELEGRAPH SERVICE EXTENSION—The Commercial Cable Company has sent out the following notice: "The administration of the Portuguese colonies announces the opening to the international telegraphic service of the offices of Mossuril, Mucuelia, Moginquale and Kinga. These form an extension of the system in the district of Mozambique. The tariff is that of Mozambique, plus ten centimes per word."

NEW GEORGIA ELECTRIC MERGER—Plans have been perfected for the complete reorganization of all the North Augusta companies and the Augusta Railway Company, under the title of the Augusta Railway and Light Company. The Augusta Railway and Electric Company, the North Augusta Electric and Improvement Company, the Augusta & Aiken Railway Company, the North Augusta Land Company and the North Augusta Hotel Company will all be merged into the new Augusta Railway and Light Company. The new company will have a capital stock of $8,000,000 preferred and $4,000,000 common. Of the authorized capitalization there will be issued at the present time only $2,300,000, composed of $800,000 preferred and $1,500,000 common.

WATER-POWER PLANTS FOR INDIA—The construction of two large Indian water-power plants is projected. The more important proposition is to build a plant on the Doodh Sagar River, located at a point about 300 miles north of Bombay, where there is a water power of not less than 2,600 feet in height. It is expected that fully 50,000 horse-power will be available all the year round. It is proposed to furnish energy to operate some sixty miles of railroad in the vicinity. The other scheme refers to the furnishing of Bombay with power for the purpose of operating electric traction lines in the city, and also supplying energy for manufacturing purposes in Bombay and vicinity. The power is to be transmitted from Meral, about forty miles distant from Bombay.

FROM CLEVELAND TO PITTSBURG BY TROLLEY—Plans have been announced of a new syndicate of New York and Cleveland capitalists for a second trolley line to connect the states of Ohio and Pennsylvania. A project for a continuation of the present lines eastward along the shore of Lake Erie to Erie, Pa., is already well advanced. The new project is to connect Cleveland and Pittsburg. F. L. Krause and F. B. Krause, of Cleveland, engineers of the proposed road, are the only members of the syndicate whose names are now made public. They have incorporated the Ohio & Pennsylvania Traction Company, with a capital of $10,000, which is nominal. The company is to be capitalized at $2,000,000. The line is to extend over private rights of way almost the entire distance between Cleveland and Sharon, where the new line is to connect with existing roads to Pittsburg. Branches are to be built to Niles, Warren, Youngstown and Mahoning Valley. The work is to be pushed during the winter.

EXTENSIVE ELECTRIC COMBINATION—It has been stated recently in Baltimore financial circles that the consolidation of the New Jersey electric railway lines, the construction of the great water-power plant on the Susquehanna River, and the activity in the affairs of the Maryland Telephone Company are connected with a deal for the consolidation of the electric railways, lighting and power interests in Baltimore, Philadelphia, Wilmington (Del.), Chester (Pa.), New Jersey towns and Washington. The banking house of Alexander Brown & Sons and the Continental Trust Company, of Baltimore, are interested with New York and Philadelphia capitalists in the project. It is understood that there will be a trunk line, over which will be transmitted a powerful electric current, to be generated by the water power of the Delaware, Susquehanna and Potomac rivers. Engineers have completed the plans, and it is said that the deal will be brought to a focus on the return of Mr. Brown from Europe. There will be a trunk line railway and a long-distance telephone system connecting the various independent telephone companies in operation at present in Baltimore, Washington and New York.

LARGE POWER PLANT FOR BOULDER COUNTY—The Boulder Creek Mining and Power Company has been organized at Bay City, Mich., with a capital of $2,000,000. Douglas C. Penoyar is president of the company. The board of directors consists of: W. S. Penoyar, Benjamin Boutell, W. S. Sharpe, H. H. Norrington, Bay City; H. S. Reynolds, Jackson, and Frank R. Jeffrey, Colorado Springs. The company is to secure from the United States and from Colorado the riparian rights in Boulder Creek, Eldora County, for power purposes, and it is proposed to build a plant of 10,000 horse-power, and to remodel and make the old Coburn mill, six miles above Boulder, into a cyanide plant of 100 tons capacity per day. The Coburn mill, where the electric plant is also to be erected, is three and one-half miles above where the city of Boulder secures its water for domestic use. A dam will be constructed and 3,000 feet of water per minute will be carried through a thirty-six-inch pipe, fifteen feet long, to a turbine wheel direct-coupled with a dynamo developing 2,000 horse-power. A fall of 475 feet is obtained in the fifteen-foot pipe. The company has also obtained title to seventy acres of mineral land, one vein of which is from fifteen to thirty feet in width, with assays ranging from $8 to $12 per ton.

NEW FRENCH ENTERPRISES—The minister of commerce, industry, posts and telegraphs has decided to open to public bids the contract for furnishing and placing the submarine cables from Breste to Dakar, from Tamatave to Reunion, from Reunion to Mauritius, and from Saigon to Pontianak. "It may be well to recall," says Thornwell Haynes, consul at Rouen, "that these cables belong to a programme made some years ago, a part of which has already been carried out, namely, the laying of the cable from Touraine to Amoy in the extreme Orient, and from Oran to Tangier, both of which have been working since June, 1901. The lines from Dakar to Konakry, from Grand Bassam to Kotonou, and from Kotonou to Libreville, have been bought. To connect the metropolis with the French occidental African lines, the French Government had thought to prolong the cable from Tanger to Teneriffe and thence to St. Louis; but this combination having the inconvenience of passing through a foreign country, it has been deemed better to lay this cable direct, which will undoubtedly offer advantages of security and rapidity, and further facilitate relations with South America, which is connected with St. Louis, *via* Senegal, by the line from Pernambuco. It has also been thought best to substitute for the Oran-Teneriffe-St. Louis project the line from Brest, the first French port of war, to Dakar, the point of support of the French fleet. The contract for this line is put for October 21 next, but this can only become definite after a law is passed supplying the necessary credits. After this, it is thought the line should be in working order within eleven months. The cable from Tamatave to Reunion and to Mauritius is intended to increase French communications with Madagascar and the French colony of Reunion; and the line from Saigon to Pontianak is to augment the interests between French Indo China and the islands of Borneo and Java. These cables are placed for contract at the same time as the line from Dakar to Brest, but are expected to be in working order in less than eleven months. The commission charged to determine on the bids submitted is presided over by M. Bérard, under secretary of state for posts and telegraphs.

RECEIVERSHIP NOTE.

ALBANY, N. Y.—Supreme Court Justice D. Cady Herrick, on October 10, appointed George C. Blakeslee receiver of the Albany & Hudson Railway and Power Company, which operates a thirty-mile third-rail electric road between Albany and Hudson. The road has been in operation since November, 1900, and the receiver was appointed under foreclosure proceedings instituted by the Colonial Trust Company, of New York city, which is the trustee under a $2,500,000 mortgage.

ELECTRICAL SECURITIES.

As a general thing there has been but little change during the week in any positive direction. Continued monetary firmness and a possible, if not probable, period of stringency seems evident. There is now no doubt that industrial speculative quarters are viewing with apprehension the continued period of unsettlement in the anthracite coal region. However, there is now but little doubt that the many lines of force focusing from both political and private quarters will bring to an early resumption all operations in the coal fields. The probability is that the miners will very shortly return to work, pending a settlement of grievances by an arbitration commission.

The money market has held firm and even has had a sort of closeness throughout the entire week. The high level has been fifteen per cent and the average ruling was about ten per cent. Some improvement on these figures is looked for at an early date, but it is the prevailing opinion in sources where authoritative information should be had, that comparatively high rates are certain for some time to come.

ELECTRICAL SECURITIES FOR THE WEEK ENDING OCTOBER 11.

New York:	Closing.
Brooklyn Rapid Transit	61⅞
Consolidated Gas	214
General Electric	177¼
Kings County Electric	206½
Metropolitan Street Railway	136½
New York & New Jersey Telephone	156
Westinghouse Manufacturing Co	211½

There is not a single stock of electrical interest which has not had a more or less slight decline. The beginning of the year, however, will no doubt evidence a sharp rally and advance in prices.

The annual report of the stockholders of the Brooklyn Rapid Transit for the year ending June 30, 1902, shows an increase in gross earnings of $602,335.58 or 5.14 per cent. The total receipts were $12,788,168.51, an increase of $652,609.04. The total increase in the cost of operation was $993,389. The gross fixed charges, including all interest and rentals, were $4,307,225.06. The net fixed charges were $3,732,633. The cost of roads, equipment and other properties owned wholly or in part by the Brooklyn Rapid Transit Company was $88,299,310.18. The total assets are $103,797,181.24. The surplus account balanced June 30, 1902, is $991,443.72.

The annual meeting of the Western Union Telegraph Company was held on October 8, and the annual report submitted. The old board of directors was reelected with the exception of John J. Mitchell, of Chicago, who was elected to succeed Stuyvesant Fish resigned, and Howard Gould who was chosen to fill the vacancy caused by the death of E. H. Perkins. The revenues for the fiscal year ending June 30, 1902, amounted to $28,073,095, an increase of $1,718,944. The expenses were $20,780,766, an increase of $1,111,863. The surplus June 30, 1902, was $10,751,002.82. There were added to the company's system during the year 2,526 miles of poles, 57,218 miles of wire and 329 offices. The number of messages transmitted by the employés of the company was 69,374,883, being 3,717,834 more than for the previous year. The average for the messages transmitted by the company were 31 cents and the average cost 25.7 cents. Since Colonel Robert C. Clowry took charge of the property in April last, the service of the company in the Eastern and Southern divisions has been reorganized. He has personally inspected a number of the principal offices and the lines in the East and South have been carefully examined. By arrangements of the operating force and through the installation of direct working circuits for repeating relay offices, a reduction of $388,746 a year in the operating expenses of the company has been effected and the service greatly improved. Since April 1, contracts have been negotiated and closed with railroad companies covering 16,800 miles of railroad.

Boston:	Closing.
American Telephone and Telegraph	162½
Edison Electric	269
Massachusetts Electric preferred	94
New England Telephone	138
Western Telephone and Telegraph	99
Philadelphia:	Closing.
Electric Company of America	9⅝
Electric Storage Battery common	89
Electric Storage Battery preferred	88
Philadelphia Electric	8¾
United Traction	47½
United Gas Improvement Co	112½
Chicago:	Closing.
Chicago Edison Light	107
Chicago Telephone	168
Metropolitan Elevated	89
National Carbon common	32
National Carbon preferred	100
Union Traction common	18
Union Traction preferred	50

PERSONAL MENTION.

MR. P. J. KRUESI, manager of the Sunlight Lava Manufacturing Company, was a New York visitor last week.

MR. MAURICE A. OUDIN, of the General Electric Company, has returned to Schenectady from a recent trip to Europe.

MR. MARK LOUD, formerly of Providence, is now located at Seattle, Wash., as electrical engineer of the Seattle Electric Company.

DR. F. A. C. PERRINE, president of the Stanley Electric Manufacturing Company, of Pittsfield, was a New York visitor on Monday of this week.

MR. C. H. NORWOOD, formerly with the Cutler-Hammer Company, Milwaukee, is now the Chicago representative of the Commercial Electric Company, of Indianapolis, Ind., and is located in the Fisher Building.

MR. STEPHEN D. FIELD, Stockbridge, Mass., visited a number of electrical friends in New York this week, and is much elated over the successful outcome of the strike on the railway in Switzerland in which he is interested. His son, who has been quite ill in a New York hospital, is now rapidly improving in health.

MR. J. W. MARSH, president of the Standard Underground Cable Company, was a New York visitor last week. The new works of his company at Perth Amboy, N. J., are rapidly nearing completion, portions of them being operated at the present time. In addition an extension of the Pittsburg works is being built.

MR. JOHN I. SABIN, president of the Chicago Telephone Company and the Central Union Telephone Company, was one of the Chicago visitors to New York last week. Mr. Sabin has had the satisfaction of witnessing a large increase in the number of subscribers to both his telephone companies during the past two years.

MR. CHARLES S. DRUMMOND, president of the Manhattan Transit Company, one of the principal directors of the British Electric Traction Company, Limited, sailed for Europe recently on the North German Lloyd liner, Kaiser Wilhelm der Grosse. According to present arrangements, he will return to New York very shortly.

MR. ARTHUR WARREN has removed his offices and the New York offices of the Westinghouse Companies' Publishing Department from 120 Broadway to the Maritime Building, Nos. 8 and 10 Bridge street, New York city. Mr. Warren, who has spent a good portion of the past year abroad looking after the interest of his companies, will make the New York office his headquarters hereafter.

MR. A. E. BARKER, manager of the Cleveland office for the Kellogg Switchboard and Supply Company, has been called to Chicago to take a position for the same company as general sales manager *vice* Mr. J. C. Belden resigned. Mr. Belden is understood to be at the head of a new company for the manufacture of insulated wires and cables. Mr. Arthur B. Kratz, from Philadelphia, takes Mr. Barker's place in the Cleveland office.

MR. JAMES P. GILBERT, who has been general superintendent of the New York & Ohio Company, Warren, Ohio, the manufacturer of Packard lamps and transformers, has resigned this position and will take the general management of the Standard Electrical Manufacturing Company, at Niles, Ohio, manufacturer of the Standard incandescent lamps. Mr. Gilbert is an able and wide-awake manufacturer, and the Standard company is to be congratulated on securing his association with it.

MR. RALPH W. POPE, secretary of the American Institute of Electrical Engineers, was married to Mrs. Katherine A. Durant, of Great Barrington, Mass., on Wednesday afternoon, October 1, at the bride's summer cottage, Ocean Grove, N. J. The ceremony was performed by the Rev. Mr. Longley, rector of Trinity Church, Asbury Park. There are few veteran electricians who are more popular than Mr. Pope. The ELECTRICAL REVIEW offers its congratulations to Mr. Pope and wishes him all kinds of good fortune.

REAR-ADMIRAL LORD CHARLES BERESFORD, of the British Navy, visited the steel plant of the John A. Roebling's Sons Company, at Trenton, N. J., on Tuesday, October 14. He was accompanied by Henry L. Shippy, the head of the New York office. The rear-admiral, after thoroughly inspecting every part of the big plant, paid a high compliment on the completeness of equipment and general management of the works. He had luncheon at the home of Ferdinand W. Roebling, treasurer of the company. There were also present Governor Franklin Murphy, State Treasurer Frank O. Briggs, John E. Clancy, D. K. Bayne, of New York, and Frederick S. Dickson, of Philadelphia.

TELEPHONE AND TELEGRAPH.

TACOMA, WASH.—The Northwest Telephone and Telegraph Company, which has franchises for constructing lines in western Washington, will at once begin work. It is stated that bonds to the extent of $400,000 have been subscribed by a New York syndicate.

WILLIAMSPORT, PA.—It is stated that the Western Union Telegraph Company is preparing to place in operation a direct telegraph line between this city and Corning, N. Y. When the wires are in operation the line will open up the entire Pine Creek Valley direct.

PORT ANGELES, WASH.—The council has been asked for a franchise for a telephone system by a company composed of local people. The names of those interested are: F. A. Jensen, C. H. Hirsch, C. J. Farmer, M. von Schlosser, W. M. Dorr and G. G. Peachman. A twenty-year franchise is desired.

HOWARD LAKE, MINN.—The Howard Lake Telephone Company has filed articles of incorporation, with a capital of $50,000. The incorporators are: John A. Peterson, O. J. Olson, John L. Munson, J. W. Custer and Nels Monson, of Stockholm; A. G. Custer, W. H. Eddy and P. E. Eddy, of Victor; H. A. Workman and G. A. Koneig, of Howard Lake.

LEGAL NOTE.

STREET RAILROADS MAKE ANSWER—The Metropolitan Street Railway Company, the Interurban Street Railway Company and the Metropolitan Security Company, through the law firm of Guthrie, Cravath & Henderson, New York city, have filed similar answers in the clerk's office of the United States Circuit Court in the suit brought against them by Mrs. Emma W. F. Page as a stockholder to prevent the leasing of the Metropolitan Street Railway system to the Interurban company. Mrs. Page, who owns 100 shares of Metropolitan Street Railway stock, alleged that the lease is a fraudulent plan of the larger stockholders to secure control of the properties. A denial is made to the charge that the promoters of the plan received the option of taking over twenty per cent of the stock of the Security company at par. The answer declares that at the time of the filing of the complainant's bill the Interurban company had issued $5,000 of its stock in payment of properties' purchase and that $12,500,000 of its stock and $15,000,000 of its debentures had been subscribed in cash. The answer denies unlawful combination as charged.

NEW INCORPORATIONS.

HARRISBURG, PA.—The Belleville Water Company. $1,000.

LUZERNE, PA.—The Luzerne Electric Light Company. $1,000.

KINGSTON, PA.—The Kingston Township Light Company. $1,000.

LANCASTER, PA.—Electric Supply and Construction Company. $6,000.

COURTDALE, PA.—The Courtdale Light, Heat and Power Company. $1,000.

DORRANCETOWN, PA.—The Dorrancetown Electric Light Company. $1,000.

CHICAGO, ILL.—Eureka Electric Company. Increased from $10,000 to $50,000.

EAST ORANGE, N. J.—Fischer Electric Company. $50,000. Incorporators: F. R. Series, Walter H. Bond, C. F. Smith.

LUBBOCK, TEX.—The Lubbock Electric Company. $2,500. Incorporators: C. E. Spotts, M. C. Abernath and H. S. Graham.

SPRINGFIELD, ILL.—St. Clair Gas Electric Company. $2,500. Incorporators: M. M. Stephens, W. N. Horner and L. D. Burnet.

DEL RIO, TEX.—Del Rio Electric Light and Power Company. $6,000. Incorporators: Fred Mayer, Henry C. Mayer, John M. Gray.

PORTLAND, ME.—The York & Boothby Company. $25,000. President, Harry C. York; treasurer, H. T. Boothby, both of Portland.

ST. PAUL, MINN.—St. Anthony Hill Electric Company. $50,000. Incorporators: Kenneth Clark, Elbert A. Young and Alonson P. Lathrop.

JERSEY CITY, N. J.—Rossman Electric Company. $2,000. Incorporators: Thomas McEwan, Frederick P. Warfield and George M. B. Hawley.

PENNINGTON, PA.—The Trenton Street Railway Company and the Delaware Valley Traction Company are seeking franchises to enter the town.

LA FAYETTE, IND.—La Fayette Pocket Telephone Company. $18,000. Incorporators: Evan Shelby, George P. Haywood and Charles A. Burnett.

JERSEY CITY, N. J.—Municipal Light and Power Company. $2,000. Incorporators: William C. Sherwood, Richard F. Tully and Henry A. Brigham, of Jersey City.

PHOENIX, N. Y.—The Phoenix Fuel and Light Company. $30,000. Directors: O. J. Hamlin, Southport, Pa.; H. E. Merriall, Geneva, and O. M. Donnelly, Phoenix.

DENVER, COL.—Themmopolis Electric Light and Power Company. $10,000. Incorporators: Charles Wallace, John L. McCoy, Martin McGrath, Ira E. Jones and W. H. Enderly.

COLUMBUS, OHIO—The Zanesville Railway, Light and Power Company. $1,000,000. Incorporators: George H. Warrington, John Roth, George M. Finch, E. R. Guenther and Thomas B. Paxton.

NEW YORK, N. Y.—Electric Arts Company; $10,000; directors: H. G. Carleton and C. E. Danforth, Jr., New York city; H. H. Pratt, Westfield, N. J. Camp Electric Construction Company; $10,000; directors: C. F. Camp and F. E. Southard, New York city, and Alexander Gregory, Brooklyn. Suburban Railway Company; $100,000; directors: J. C. Simon, William Ballin and Max Cohen, New York city.

ELECTION OF OFFICERS.

COMMERCIAL CABLE ELECTION—The board of directors of the Commercial Cable Company, at a meeting held in New York city on Tuesday of this week, elected Clarence H. Mackay president of the company, and George G. Ward chairman of the board of directors and of the executive committee. Mr. Ward continues to be vice-president and general manager. Mr. Mackay was also elected president, and A. B. Chandler continues as chairman of the board of directors of the Postal Telegraph-Cable Company and the Pacific Telegraph-Cable Company.

ELECTRIC LIGHTING.

GLENCOE, ONTARIO—It is rumored that a municipal electric light plant will be established here.

PRINCE ALBERT, NORTHWEST TERRITORY—Tenders are asked by the town council for the installation of an electric light plant.

COLLINGWOOD, ONTARIO—The Collingwood Shipbuilding Company intends eventually to install an electric plant for lighting its works.

DAYTON, OHIO—The Mandelbaum Syndicate is preparing to build a $2,000,000 power-house here to operate traction lines through Dayton from Cincinnati to Toledo.

SYRACUSE, N. Y.—The Syracuse Lighting Company, it is stated, will expend about $250,000 for additions to its plant, the work to be begun arly in the spring.

OAKWOOD, OHIO—Permission has been granted to the Dayton Electric Light Company to erect poles along the Lebanon pike for the purpose of furnishing electric light to this village.

MARQUETTE, MICH.—Work on the new plant for the Houghton County Electric Light Company has been commenced, and it is said that it will be completed within three months.

SEATTLE, WASH.—The Seattle Electric Company proposes to connect West Seattle and this city by an electric line, and has applied for a franchise. It is intended ultimately to extend the line to Alki Point.

PITTSBURG, PA.—It is stated that the Washington & Canonsburg Railway Company will connect Pittsburg and Wheeling, W. Va., by an electric line, and that the system will be completed within three years.

PITTSBURG, PA.—An increase from $300,000 to $450,000 in the capital of the Pennsylvania Heat, Light and Power Company has

been voted in order to provide for extensive improvements and extensions of the plant.

FAIRPORT, N. Y.—The village of Fairport has purchased of DeLand & Company the franchise which that company held to furnish electric light to the village, and all lighting is now furnished by the village itself under the direction of the municipal board.

DAYTON, OHIO—The People's Railway Company has accepted the franchise granted by the county commissioners, with a slight modification. The franchise is for twenty-five years, and under its provisions the company is to have the work completed by July, 1903.

MOUNT PLEASANT, PA.—The Mount Pleasant Electric Light, Heat and Power Company, owned by O. P. and J. Wade Shupe, John and Marian Husband, John L. Ruth and Thomas N. Seaton, has been sold to the Pittsburg, McKeesport & Connellsville Street Railway Company. The consideration was $70,000.

FOUNTAIN GREEN, UTAH—A company of local moneyed men has recently been incorporated with a capital of $20,000, having in view the building of an electric light plant in this town. The officers of the company are: George Carter, president; Henry Jackson, vice-president; A. J. Aagard, Jr., secretary and treasurer.

WAUKEGAN, ILL.—Plans are under consideration for the erection here of a $300,000 plant by Samuel Insull and Frank Baker, of Chicago, to supply electricity to all towns along the north shore as far south as Evanston. It would also operate the Waukegan & Fox Lake Electric Railway soon to be built west from Waukegan.

HATTIESBURG, MISS.—The Hattiesburg Light and Power Company has been incorporated in Hattiesburg, Miss., for the purpose of acquiring by purchase or otherwise a plant or plants devoted to the manufacture and employment and utilization of light, heat and power by electricity or otherwise. The incorporators are: M. Hemphill, R. H. Hemphill and H. A. Hemphill.

KALAMAZOO, MICH.—Twelve thousand acres of land have been purchased by the Kalamazoo Valley Electric Company in the vicinity of Pine Creek. It is stated that a dam is to be built, which will cost $125,000, and will furnish about 2,800 horse-power. One of the principal purposes of the company is to furnish power for an electric road between Grand Rapids and Kalamazoo. Construction will soon begin.

AUBURN, N. Y.—It is announced that by January 1, 1903, Auburn and Syracuse will be connected by electric road. The work has already been carried on from the Skaneateles end to two miles east of the Camillus town line, leaving seven miles of grading and ten miles of track laying still to be done. James S. McCabe, it is reported, will be superintendent of the company, C. D. Beebe, general manager, and R. A. Dyer, Jr., chief electrician.

FULTON, N. Y.—The new Fulton Fuel and Light Company has been organized for the purpose of supplying heat and light to the residents of the city. The officers of the company are as follows: President, James A. Foster, Fulton; vice-president, Herbert W. Noble, of Detroit; treasurer, William E. Moss, of Detroit; secretary and general manager, Charles W. Tippey, of Detroit. The company expects to have its plant ready for operation by December 1.

CAPE MAY, N. J.—The new owners of the Cape May Electric Company's plant have reorganized the company under the name of the Cape May Electric Light Company, and have capitalized their corporation at $100,000. The officers of the new company are: President, Frank K. Bull, of Racine, Wis.; vice-president, Edward C. Brainard, of Chicago; secretary and treasurer, Edward E. Mandeville, of Chicago; local superintendent, James W. Hildreth, of Cape May. A new plant will be built along the lines of the Pennsylvania Railroad, and will be in operation by February 1 of next year.

WASHINGTON, D. C.—The Potomac Electric Power Company has purchased all the property, assets and franchises of the United States Electric Lighting Company, the consideration being $3,250,000 of the Potomac company's stock, the latter company also agreeing to pay the debts of the United States company. The conveyance is made subject to a mortgage of $650,000, securing certificates of indebtedness and debenture bonds issued in 1897 and 1898, the mortgagee being the Guaranty Trust Company, of New York. The new company is incorporated under the laws of the District of Columbia.

ELECTRIC RAILWAYS.

NORWALK, OHIO—The Mansfield-Crestline electric railway is about completed, and the company expects to have cars running by November 1.

MOLINE, ILL.—Surveys of the Kewanee, Cambridge & Geneseo interurban line have been completed. The line as now contemplated will have a length of twenty-seven and one-half miles.

CLEVELAND, OHIO—The directors of the Cleveland, Elyria & Western electric railway will make another extension of its lines. This extension will connect the towns of Wellington and Mansfield.

CHATTANOOGA, TENN.—An electric line is to be built from Benton, Tenn., by way of Bristol, to Ducktown. The road will be forty-six miles long and will cost $400,000, the money to be furnished by New York and Philadelphia capitalists.

ELMIRA, N. Y.—The bonds of the Elmira & Waverly electric road, amounting to about $400,000, have all been sold, and the contract for the construction of this line, which will connect Elmira with Waverly and intermediate points, has been let.

RED BANK, N. J.—A new trolley road is to be built this fall or early in the winter between Red Bank and Oceanic. The entire right of way has been secured. The new road will connect with the Monmouth County Electric Railroad, and will run through Fair Haven.

MERCER, PA.—Contracts for the new line to extend from the Bessemer, at Euclid, to Plaff's mines, near Kaylor, have been awarded. Work will be commenced at once. The road will cost $1,500,000 and will open up practically new and very valuable coal property.

CAPE GIRARDEAU, MO.—The Cape Girardeau & Jackson Railway Company has been formed with a capital of $300,000, to build an electric railway from here to Jackson, as well as lines in each of the two towns. The stock was taken by capitalists of St. Louis, Cape Girardeau and Jackson. Work will be commenced as soon as possible.

AUGUSTA, ME.—E. Burton Hart, Jr., New York; A. H. Shaw, Samuel R. Percy, Frank E. Southard, Bath, Me., and Frederick H. Wilson, Brunswick, Me., are the directors of the new Auburn, Mechanic Falls & Norway Street Railway Company, which proposes to build an electric road from Auburn through the towns of Minot, Poland, Mechanic Falls and Oxford, to Norway. The road will be twenty-four miles in length. The capital of the company is $700,000.

PITTSBURG, PA.—Plans have been approved for a new trolley line from McKeesport to East Pittsburg. Work on the line is to be started at once, and a complete double track system will be installed. The new line will open up one of the most populous districts of the Monongahela and Turtle Creek valleys. The new line will be a division of the Pittsburg, McKeesport and Connellsville system. At East Pittsburg the line will make connections with the new Wilkinsburg & East Pittsburg line.

MOUNT AYR, IOWA—The Des Moines, Mount Ayr & Southern Electric Railway Company has been incorporated with a capital of $600,000, with officers as follows: President, F. E. Sheldon; vice-president, J. F. Wall; secretary, H. C. Beard; treasurer, Clyde Dunning; directors, F. E. Sheldon, Lyman Waterman, J. O. Fry, Clyde Dunning and J. F. Wall. All the incorporators are Mount Ayr men, and the company's principal place of business will be in that city. It is the purpose of the company to build an electric line from Creston to Mount Ayr. Work will begin next spring.

BLAIRSVILLE, PA.—G. W. McHenry and A. Abbattachio, of Latrobe; J. A. C. Ruffner, of Greensburg, and M. E. Brown and T. C. Brown of this town, recently held a meeting and made preliminary arrangements for the construction of a trolley line between Blairsville and Latrobe. They have applied for a charter for a line which will include Cokeville, Hillside, Ridgeview, Park, Millwood, Derry, Bradenville and a number of smaller places. They will also apply for an extension to Indiana, a distance of sixteen miles. When completed, the system will have a length of about thirty-five miles. It is intended to make this the beginning of a trolley system that will finally extend to Johnstown, making connections with some of the coke country lines and also with Pittsburg.

INDUSTRIAL ITEMS.

THE FIBRE CONDUIT COMPANY, Orangeburgh, N. Y., is just placing on the market a new underground conduit.

THE ROYAL ELECTRIC COMPANY describes its type E transformers and alternating-current generators of the induction type in its latest bulletins, which will be sent to any one interested, upon application.

THE ELECTRIC APPLIANCE COMPANY, Chicago, Ill., is having a large sale among telephone companies and manufacturers for the Noxem telephone receiver. Circulars giving full description and prices are now being distributed.

THE CLEVELAND CONSTRUCTION COMPANY, Cleveland, Ohio, was the engineer of the Washington, Baltimore & Annapolis Railway described in the paper read by Mr. B. G. Lamme before the American Institute of Electrical Engineers, September 26, 1902.

THE PITTSBURG VALVE FITTINGS COMPANY is building new works at Barberton, Ohio, and has placed a contract with the Westinghouse Electric and Manufacturing Company for the electrical equipment, which includes generators, motors and switchboards.

THE AMERICAN BLOWER COMPANY, Detroit, Mich., has issued a small booklet illustrating its plant and equipment. There is a series of seventeen half-tones, each of which is indexed by a descriptive caption, the whole being very tastefully executed and handsomely printed.

THE GAMEWELL FIRE ALARM TELEGRAPH COMPANY, New York city, is distributing a complimentary souvenir containing the address by Joseph W. Stover to the thirtieth annual convention of the International Association of Fire Engineers held in New York city on "Progress in Fire Alarm Telegraphy."

THE HARRISBURG FOUNDRY AND MACHINE WORKS, Harrisburg, Pa., has published a magnificent catalogue entitled "A System of Engines." Besides a work of art typographically, the volume is replete with useful information and descriptive matter relating to engines and engine parts. The company would be pleased to receive correspondence with regard to this publication.

THE JEWELL ELECTRICAL INSTRUMENT COMPANY, Chicago, has removed its factory and offices to 61 and 63 Union Park Court, near Carroll avenue. This company is placing on the market a new line of pocket ammeters and voltmeters, and also a new line of baby switchboard instruments. The company has just published a new bulletin descriptive of these new instruments.

THE LUNKENHEIMER COMPANY, Cincinnati, Ohio, is meeting with great favor with its regrinding valves made of gun metal. These are designed with screw and flange ends for 200 and 350 pounds working pressure, one-eighth of an inch up. These valves are extensively used and in continuous service in the United States Navy, locomotives, lake and river boats and high-pressure plants.

THE C. W. HUNT COMPANY, with works and office at West New Brighton, Staten Island, has issued an attractive pamphlet describing the Hunt cable rollers for handling coal and merchandise. This pamphlet is elaborately illustrated, and particular attention has been given to describing in detail each part of the apparatus. This will be sent to any one interested upon application to the company.

THE ATWATER KENT MANUFACTURING WORKS, Philadelphia, Pa., which has recently moved into larger quarters, has now twice the floor space previously occupied; and the rapidly increasing business makes it probable that a further extension will soon be necessary. This company is the manufacturer of the Monoplex telephone. Information will be forwarded upon request to the company.

THE SORENSEN MANUFACTURING COMPANY, Ravenna, Ohio, is the manufacturer of a line of static induction machines and X-ray supplies. A recent catalogue describes this apparatus and gives illustrations of several of the machines. The pamphlet is further adorned by several skiagraph representations, as produced by the apparatus of this company. This pamphlet will be mailed to any one upon request to the company.

THE CRANE COMPANY, Chicago, Ill., has recently issued a very complete pocket catalogue of steam goods. This catalogue appears to cover everything that might be called for in steam fitting. It is replete with good illustrations, and price lists and dimensions are carefully worked out. A comprehensive index makes the finding of any particular fitting an easy matter. This catalogue will be sent to any one interested upon application.

THE FORT WAYNE ELECTRIC WORKS, Fort Wayne, Ind., is calling attention to its "Wood" type A oil transformers, enclosed direct-connected power circuits, arc lamps, small standard motor panels, enclosed direct-current 110-volt arc lamps and "Wood" measuring instruments in recent bulletins. The October calendar is in the characteristic Fort Wayne style, embellished with two engravings of the "Wood" direct-current circuit-breaker.

THE H. W. JOHNS-MANVILLE COMPANY manufactures a number of specialties from its vulcabeston packing. This material has become popular for steam, gas and hot-air work, and is claimed to be desirable for service where ammonia, acids, alkalies, etc., are to be contended with. A specialty is the lubricated asbestos piston rod packing and brass rod rings and gaskets. In addition to these, a number of other specialties are manufactured from this material. Complete information may be had upon request to the company at 100 William street, New York city.

THE AMERICAN ENGINE COMPANY, Bound Brook, N. J., builder of the American Ball engines and electric machinery, is installing a number of large plants, and states that the Duplex compound engine is meeting with more pronounced success every day. The large plant which this company is installing in the Ansonia apartments, in New York city, is practically completed; and another large equipment of compound engines of large sizes is being installed in the new store of N. Snellenburg & Company, of Philadelphia. The New York office of the American Engine Company is at 95 Liberty street.

THE WESTERN ELECTRICAL SUPPLY COMPANY, St. Louis, states that the demand for its new type Peerless incandescent lamps is greater than ever. It states that the factory has recently doubled its capacity, in order to take care of the enormous output. It is now making some very attractive prices on this lamp. It says that the reduction in price has nothing to do with the quality of the lamp, as it is making better lamps to-day than ever before. It has a very attractive little booklet which gives more detailed information about incandescent lamps in general, and Peerless in particular. It will be mailed upon application.

THE MICA INSULATOR COMPANY, New York city, is placing on the market a process cloth under the name of linotape. This is manufactured in any width from one-quarter of an inch to thirty-six inches, and samples will be sent gratuitously upon application. This is claimed to be a perfect insulating tape, both mechanically and electrically. The foundation for this tape is a closely woven cloth, made so as to procure great mechanical and electrical strength before treating. The coating consists of a film of oxidized Empire oil on both surfaces. This coating, it is claimed, never hardens nor cracks, and it renders the cloth impervious to moisture and proof against acids and alkali.

THE SYRACUSE RAILROAD CONSTRUCTION COMPANY, which is building a twenty-five-mile electric railroad between Auburn and Syracuse, N. Y., has closed a contract with the Westinghouse Electric and Manufacturing Company for two 650-kilowatt, engine-type alternators, delivering three-phase current at 360 volts and 3,000 alternations; also, for five 400-kilowatt rotary converters, together with raising and lowering transformers for operating a 15,000-volt transmission line from two substations. A complete switchboard is included. The generators are to be direct-connected to two twenty-two and forty-four by forty-eight-inch, cross-compound, horizontal Corliss engines. The engines are to receive steam at 150 pounds, and are to run at 100 revolutions per minute, and are rated at 1,000 horse-power each, with a maximum of 1,800 horse-power.